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PUBLIC NOTICES.

HEATING.

The Commissioners of HIS MAJESTY'S WORKS, &c., are prepared to receive TENDERS before 11 a.m. on Thursday, 25th February, 1932, for ACCELERATED LOW-PRESSURE HOT WATER HEATING, &c., at the Head Post Office, Brighton, Sussex.

Drawings, specification, a copy of the conditions and form of contract, bills of quantities, and forms for Tender, may be obtained from the CONTRACTS BRANCH, H.M. Office of Works, King Charles-street, London, S.W. 1, on payment of One Guinea. (Cheques payable to The Commissioners, H.M. Office of Works.) The sums so paid will be returned to those persons who send in Tenders in conformity with the conditions. 8106

University of London.

A COURSE of TWO LECTURES, with lantern illustrations, on "PHYSICAL LINES OF ELECTRIC FORCES AND THEIR APPLICATION TO THE INTERPRETATION OF THE ELECTRO-MAGNETIC FIELD," will be given by SIR JOSEPH J. THOMSON, O.M., F.R.S. (Master of Trinity College, Cambridge), at UNIVERSITY COLLEGE, LONDON (Gower-street, W.C. 1), on THURSDAYS, FEBRUARY 18th and 25th, at 5.30 p.m. At the First Lecture the chair will be taken by Professor G. P. Thomson, F.R.S. (Professor of Physics in the University).

ADMISSION FREE, WITHOUT TICKET.

S. J. WORSLEY, Academic Registrar.

8103

London County Council.

PRINCIPAL of Westminster Technical Institute, Vincent-square, S.W. 1, REQUIRED in September. The activities of the Institute include:—(1) A school of art, day and evening classes; (2) a junior technical day school of cookery and waiting for training boys as chefs and professional waiters; (3) evening classes in Civil and Structural Engineering, Architecture, Surveying, and Valuations, Gas Engineering and Supply (a special feature of the Institute is the large classes in Gas Engineering and Supply); (4) evening classes in Advanced Cookery for men and women. Salary scale, £850-£50-£1060, less 10 per cent.

Apply, EDUCATION OFFICER (T. 1), County Hall, Westminster Bridge, S.E. 1 (stamped addressed foolscap envelope necessary), for particulars and form, to be returned by 29th February. Canvassing disqualifies. 8114

Middlesex Education Committee.

ACTON TECHNICAL COLLEGE.

HIGH-STREET, ACTON, W. 3.

REQUIRED, from the commencement of the Summer Term, ASSISTANT MASTER, mainly for CHEMISTRY and PHYSICS. Good Honours Degree in General Science, Diploma in Education, and some Teaching Experience desirable. Botany an advantage. Salary: Burnham Scale (London area), less 10 per cent. Appointment subject to satisfactory medical examination. Application forms, which should be returned to the Principal by 20th February, may be obtained by sending a stamped addressed foolscap envelope to

H. M. WALTON, Education Offices (H),
10, Great George-street, London, S.W. 1. 8115

Borough of Ilford and Borough of Barking.

ILFORD AND BARKING JOINT SEWERAGE COMMITTEE.

STAND-BY GENERATING PLANT—CONTRACT NO. 9A.

The above Authorities are prepared to receive TENDERS for the SUPPLY and ERECTION of TWO OIL-DRIVEN GENERATING SETS of alternatively 265 kW capacity, or 250 kW capacity, each including Diesel Engines, Alternators, Switchboard and Appurtenant Works, to be erected on the site of the new Joint Sewage Pumping Station at Barking, Essex.

General conditions, specification and form of Tender may be obtained at the office of the Engineers, Messrs. W. H. Radford and Son, Civil Engineers, Albion Chambers, King-street, Nottingham, on deposit of Two Guineas (cheque), which will be returned on receipt of a bona fide Tender.

The lowest or any Tender will not necessarily be accepted.

Sealed Tenders to be delivered to the undersigned on or before the first post on Thursday, March 10th, 1932, endorsed "Stand-by Generating Plant."

By order of the Joint Committee of the above Authorities.

ADAM PARTINGTON, Clerk to the Committee.

Town Hall, Ilford,
1st February, 1932. 8102

Metropolitan Water Board.

TENDERS FOR THE SUPPLY OF SLUICE VALVES, HYDRANTS, &c., AND PHOTO PRINTS.

The Metropolitan Water Board invite TENDERS for the SUPPLY of the undermentioned STORES and SERVICES for the periods of six and twelve months, commencing 1st April, 1932:—

TENDER No. 21.—SLUICE VALVES and HYDRANTS, &c.

TENDER No. 27.—PHOTO PRINTS, &c.

Tenders must be submitted on the official forms, which may be obtained on and after Monday, 1st February, 1932, from the Chief Engineer, by personal application at the offices of the Board (Room 156) or upon forwarding a stamped addressed sack envelope. Applicants should refer to the number of the Tender for which forms are required. Samples of the paper required in connection with Tender No. 27 can be seen at the offices of the Board (Room 201).

Tenders, enclosed in sealed envelopes, addressed to The Clerk of the Board, and endorsed in the manner indicated in the form of Tender, must be delivered at the offices of the Board (Room 122) not later than 11 a.m. on Monday, 22nd February, 1932.

The Board do not bind themselves to accept the lowest or any Tender.

G. F. STRINGER, Clerk of the Board.

Offices of the Board,
173, Rosebery-avenue, E.C. 1,
25th January, 1932. 8072

SITUATIONS OPEN.

TO ADVERTISERS UNDER BOX NUMBERS IN THIS CLASSIFICATION.

For the benefit of applicants, the Proprietors are prepared to insert brief notices that vacancies are filled, upon receipt of notifications from the Advertisers. These notices (limited to one line) will be free of charge and co-operation is asked for.

The Engineer

PRINCIPAL CONTENTS OF THIS ISSUE
ARRANGED FOR CARD INDEXING.

Erosion of Steam Turbine Blades. (P. 146)
(F. W. GARDNER.) THE ENGINEER, 5 - 2 - 32.

The Grid and the Electrical Manufacturer. (P. 159)
THE ENGINEER, 5 - 2 - 32.

British and American Rolled Steel Sections. (P. 146)
(B. L. HURST.) THE ENGINEER, 5 - 2 - 32.

Trend of British Locomotive Design. (P. 149)
(W. A. TUPLIN.) THE ENGINEER, 5 - 2 - 32.

Present Position of the Iron and Steel Industry. (P. 155)
THE ENGINEER, 5 - 2 - 32.

Mechanism of Electric Locomotives. (P. 153)
(J. D. TWINBERROW.) THE ENGINEER, 5 - 2 - 32.

Scrap Baling Press. (P. 163)
THE ENGINEER, 5 - 2 - 32.

INDEX TO ADVERTISEMENTS, PAGE 59.

PUBLIC NOTICES.

Bombay, Baroda and Central India Railway Company.

The Directors are prepared to receive up to Noon on Wednesday, 17th February, TENDERS for the SUPPLY of

DUPLICATE PARTS FOR LOCOMOTIVES (Axleboxes, &c.).

Tenders must be made on forms, copies of which, with specification, can be obtained at these Offices on payment of 10s. each (which will not be returned).

The Directors do not bind themselves to accept the lowest or any Tender.

S. G. S. YOUNG, Secretary.

Offices:—The White Mansion,
91, Petty France, Westminster, S.W. 1,
2nd February, 1932. 8107

County Borough of Wolverhampton.

BARNHURST SEWAGE PURIFICATION WORKS. CONTRACT NO. 10.

TO MAKERS OF PUMPS AND ELECTRIC MOTORS.

The Corporation is prepared to receive TENDERS for the SUPPLY of a CENTRIFUGAL PUMP driven by an ELECTRIC MOTOR for pumping sewage which has received tank treatment.

The pump will be required to deliver about 2000 gallons of sewage per minute against a total head of about 25ft.

Tenderers will be required to submit prices for the manufacture, delivery and installation of the required plant, piping, switchgear and other details.

On and after the 27th January, 1932, specifications, bills of quantities and forms of Tender may be obtained from the Engineers, Messrs. Dodd and Watson, MM. Inst. C.E., Wellington House, Bennetts Hill, Birmingham, on payment of a deposit of £1, which will be returned only on the receipt of a bona fide Tender and the return of all documents.

A drawing showing the various details of the pumping station and the pipe lines will accompany the specification.

Sealed Tenders, addressed "J. Brock Allon, Esq., Town Clerk Wolverhampton," and endorsed "Tender for Contract No. 10," should be delivered at this office not later than Noon on Wednesday, February 17th, 1932.

The Corporation does not bind itself to accept the lowest or any Tender.

J. BROCK ALLON, Town Clerk.

Town Hall, Wolverhampton,
22nd January, 1932. 8068

PUBLIC NOTICES.

London County Council.

TENDERS are INVITED for the EXECUTION of GENERAL WORKS and REPAIRS (including Jobbing Work), exclusive of Works of a Mechanical character, required in connection with the Council's Main Drainage System (including its extensions outside the County), Thames Floods Prevention Works, Street Improvements, Bridges, Embankments, Subways, Tunnels, Woolwich Ferry and other Works, under the supervision of the Chief Engineer of the Council on a schedule of prices for Contract for one, two or three years, commencing 1st April, 1932.

Tenders are invited for:—

(a) The whole of the above Works.
(b) The Works on the North Side of the River Thames and the Thames Bridges and Tunnels and Woolwich Ferry.
(c) The Works on the South Side of the River Thames.

Average annual value of the work in recent years approximately £60,000.

Specification, form of Tender, &c., may be obtained on and after Monday, 8th February, 1932, on application to the Chief Engineer, Old County Hall, Spring-gardens, S.W. 1, upon payment of £3 by crossed cheque, or order payable to the London County Council. (NOTE.—CASH WILL NOT BE ACCEPTED.) This amount will be returnable only if a bona fide Tender has been sent in and not subsequently withdrawn. Full particulars of the work may be obtained on personal application, and the contract documents may be inspected before payment of the fee.

Remittances by post should be addressed to the Chief Engineer, Old County Hall, Spring-gardens, S.W. 1. Personal inquiries at Room 2, No. 3, Warwick House-street, Cockspur-street, S.W. 1.

The contractor will be bound to observe the provisions of a fair wages clause, the terms of which are set out fully in the instructions for Tender and form of contract, and in the "London County Council Gazette."

No Tender received by the CLERK OF THE COUNCIL at County Hall, Westminster Bridge, S.E. 1, after 4 p.m. on Monday, 29th February, 1932, will be considered.

The Council does not bind itself to accept the lowest or any Tender. 8109

The Manchester Steam Users' Association.

For the Prevention of Steam Boiler Explosions and for the Attainment of Economy in the Application of Steam, 20, QUAY-STREET, DEANSGATE, MANCHESTER. Founded 1854, by SIR WILLIAM FAIRBAIRN.

Certificates of Safety issued under the Factory and Workshops Act, 1901. Compensation for Damages and Liabilities paid in case of Explosions. Engines and Boilers Inspected during construction. 6762

PUBLIC NOTICES.

Electricity Supply Board.

IRISH FREE STATE.

VACANCY FOR SENIOR ASSISTANT HYDROMETRIC ENGINEER.

The Electricity Supply Board invite APPLICATIONS for the POSITION of SENIOR ASSISTANT HYDROMETRIC ENGINEER in the Civil Engineering Department. Essential qualifications: University Civil Engineering Degree, or equivalent. Maximum age 30 years on 1st January, 1932. Salary, £300 per annum, by £20 per year to £500. The point at which the successful applicant will enter this scale will be determined by the Board.

Applications, enclosing original testimonials, should be made in writing to the undersigned, from whom full particulars may be obtained. Latest date for receiving applications:—17th February, 1932.

(Signed) PATRICK J. DEMPSEY, Secretary.

Electricity Supply Board,
60-62, Upper Mount-street, Dublin.
Date: 1st February, 1932. 8110

SITUATIONS OPEN.

COPIES OF TESTIMONIALS, NOT ORIGINALS, UNLESS SPECIFICALLY REQUESTED.

AN EXPERIENCED
ENGINEER-SALESMAN
REQUIRED
to Sell Transmission Belting, Packings, &c., made of Leather treated by new process and having immense advantages. Great scope and excellent prospects for right man. Preference given to successful Leather Belting Salesman experienced in Transmission Problems. Remuneration by salary and commission. Write full details of past record, present employment, age, salary required.—Address, P2008, The Engineer Office. P2008 A

BRIDGE and STRUCTURAL DESIGNER and ESTIMATOR WANTED for large European Firm of Engineers and Manufacturers in India. Must be of good address and possess specialised experience, with, for preference, practical shop knowledge of manufacture.—Write, with copies of certificates and details of experience, and if able to do so state salary required, to Box Z.B.399, Deacon's Advertising Offices, Fenchurch-avenue, London. 8124 A

REQUIRED, an ENGINEER to Superintend a Small High-speed Printing and Pressing Plant in Slough Factory.—Address, stating age, salary, and experience, P2023, The Engineer Office. P2023 A

REQUIRED by Large Firm of Boilermakers, Experienced SALES REPRESENTATIVE for Boilers and similar work in the London area and South-East of England. Specify age, salary required, experience, full details of work previously done.—Address, P2011, The Engineer Office. P2011 A

SALESMAN WANTED for London Firm, Take Control of Dept. dealing with Pulleys, Belting Tubes, and Fittings, &c.—State full particulars to Box S. 660, c/o Dawson's, 5, Abchurch-yard, E.C. 4. 8105 A

SMELTING SHOP MANAGER.—WANTED AT ONCE by prominent North of England Iron and Steel Company, fully qualified OPEN-HEARTH SMELTING SHOP MANAGER, to be also accustomed to the control of men.

Only experienced applicants will be considered.

Applications, giving full details, qualifications and experience, to be addressed to 8117, The Engineer Office. 8117 A

WORKS MANAGER for HIGH-GRADE ELECTRICAL INSTRUMENTS, 80 hands; sound ENGINEERING and ELECTRICAL training essential, preferably with Draughtsman's experience. Machine Shop Practice, Tool Design, and knowledge Modern Batch Production Methods and Costing. State age, M. or S., full details, qualifications, experience and salary desired; when available; copies references only.—Address, 8112, The Engineer Office. 8112 A

WANTED, DRAUGHTSMAN, Accustomed to Design of Centrifugal and Turbine Pumps for all duties.—Address, stating age, experience, and salary required, 8101, The Engineer Office. 8101 A

DRAUGHTSMAN REQUIRED for Edinburgh District, to undertake the Design of Hydraulic and General Machinery. State age, experience, salary required, and enclose copy testimonials.—Address, 8113, The Engineer Office. 8113 A

DRAUGHTSMAN. — Thoroughly Competent DRAUGHTSMAN WANTED for works about 25 miles south of London. Must have had considerable experience in designing of high-class machinery. State concise details of experience and salary required.—Address, 8046, The Engineer Office. 8046 A

SITUATIONS OPEN (continued) Page 2.
SITUATIONS WANTED, Page 2.
PUBLIC NOTICE, Page 2.
AUCTIONS, Page 60.
PATENTS, Page 4.
EDUCATIONAL, Page 2.
FOR HIRE, Page 3.
BUSINESSES and PREMISES (For Sale, etc.), Page 60.
AGENCIES, Page 2.
MISCELLANEOUS, Page 4.
FOR SALE, Pages 4 and 60.
WORK WANTED, Page 4.
PUBLISHERS' NOTICES, Pages 3, 4 and 60.

For Advertisement Rates see First Column Overleaf.

The Engineer

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"THE METALLURGIST."

This Supplement, which deals with the Science and Practice of Metallurgy, both ferrous and non-ferrous, is published free with the last issue of THE ENGINEER in each calendar month.

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Letters relating to the Advertisement and the Publishing Department of the Paper are to be addressed to the Publisher, all other letters are to be addressed to the Editor of THE ENGINEER.

THE ENGINEER DIRECTORY.

This Directory, which is published annually in the interests of advertisers in THE ENGINEER, may be obtained free of charge on application to the Publisher.

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WANTED, FOREMAN, Fitting and Erecting Shop. Experience with first-class Heavy Motor Vehicles and rapid output. State wages required and experience.—Address, 8116, The Engineer Office. 8116 A

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ENGINEER (CIVIL and MINING), 29, Apprentice-ship and university, expert theodolite man, with experience oil companies abroad, and as University Lecturer at home. Has Spanish, shorthand, typing and technical secretarial training. Free, fit go anywhere.—Address, P2007, The Engineer Office. P2007 B

ENGINEER (Civil), B.Sc., A.M.I.C.E., SEEKS WORK, home or abroad ; age 33 ; nine years' railway construction and maintenance, bridge building, survey, &c. Fluent Arabic and Portuguese, fair French. Well recommended.—Address, P2001, The Engineer Office. P2001 B

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A Seven-Day Journal

Work on the French Liners.

WORK on the construction of the liner "Champlain" has been suspended at the Chantiers de Penhoët, at St. Nazaire, and the 2600 men engaged upon her have been discharged, as the result of the failure of the Compagnie Générale Transatlantique to fulfil its financial obligations towards the Penhoët firm, following upon the refusal of the Senate to accept the vote of the Chamber of Deputies authorising the Government to provide 300 million francs to finance the company. If the Government does not come to the assistance of the Compagnie Générale Transatlantique within a few days, work will also be stopped upon the 73,000-ton super-liner "T 6," when an additional 2000 men will be discharged, making a total of 4600 out of 6000 men employed in the yard. The effect of this action at a time when the whole of France has become alarmed at the increasing unemployment, will be to put pressure upon the Government to assist the "Transat" line, but the Government is helpless in view of the Senate's opposition to its scheme. The difficulties in the way of balancing the French Budget have something to do with the refusal of the Senate's Commission to authorise the expenditure proposed by the Government. As recorded in THE ENGINEER of January 22nd, the propelling machinery of the liner "Champlain" is of the geared turbine type, comprising a twin-screw arrangement of triple turbines, while the machinery for the super-liner is turbo-electric, and is being constructed at the Belfort works of the French society "Alsthom." On Wednesday last M. Laval, the Prime Minister, and M. de Chappedelaine, the Minister of Merchant Marine, appeared before the Finance Committee of the Senate and discussed the measures to be taken to aid the French line. It seems likely that an immediate credit to enable the payment of urgent obligations and another for the maintenance of the line during the next few months will be agreed to.

Smoke Abatement.

LAST Friday, January 29th, a report was submitted to the Council of the National Smoke Abatement Society on behalf of the Executive Committee, and the Council adopted the following resolutions:—That local authorities be urged to combine for the purpose of setting up suitable statutory regional organisations for the administration of smoke abatement law; that pending the formation of statutory regional organisations, local authorities be urged to establish advisory committees similar to those already in existence; and that the support of the National Smoke Abatement Society be given to such projects as will further these proposals. In the report of the Executive Committee it was pointed out that powers exist under the Public Health Acts by which united districts for the purposes of smoke abatement may be constituted, but that up to the present only one such joint administrative district—the Sheffield, Rotherham and District Smoke Abatement Committee—had been formed. Reference was also made to the considerable variations in the administration of the law relating to smoke emission throughout the country, and to the fact that in a large number of cases the law was either completely ignored or was put into operation only intermittently and ineffectively. The cost of administration by a statutory regional organisation was likely to be much less than the cost of an equivalent service carried out by the constituent authorities individually. The final points in the report were that smoke knew no boundaries and the efforts of one authority might therefore be largely nullified by the inaction of adjoining authorities; and that the present system had been in operation for fifty-six years and was unlikely to lead to greater success than had been already achieved.

A Wireless Telephone Service to South Africa.

ON Monday last, a public radio telephone service was opened between this country and South Africa by a conversation over a distance of more than 5000 miles between the Prime Ministers of Great Britain and the Union of South Africa. Mr. MacDonald spoke from 10, Downing-street, and General Hertzog from Government House, Cape Town. Reception is said to have been extremely good, both here and in South Africa, and the talk, as broadcast by the B.B.C., was clearly heard by a large number of listeners. With the opening of the service the facilities for wireless telephonic communication within the Empire have been nearly completed, as the only important link that remains to be established is that with India. For the present the service to South Africa will be limited to subscribers in London and to places south of a line drawn from Cape Town to De Aar and to Port Elizabeth. An extension to the range as far south as Johannesburg is, however, to be provided in the near future, while, on this side, arrangements are being made for extension to nearly the whole of Europe, the North American Continent, and a large part of South America. At the English end of the system, which is operated by the Post Office, the transmitting station is at Rugby and the receiving station at Baldock, Hertfordshire, whilst the corresponding South African stations are at Klipheuval and Milnerton, both near Cape Town. The transmitting and receiving links are combined and controlled at the London Trunk Exchange and at the Cape Town Telephone Exchange, and ready access is obtained from these points to the land line telephone systems of the two countries.

The New Cunarder.

LITTLE falls to be recorded with regard to progress made in the direction of the resumption of work on the new Cunard liner now under construction at John Brown's Clydebank Yard. In reply to a question in the House of Commons on Tuesday last, the Prime Minister stated that he accepted unreservedly the statement of the Cunard Company's chairman in his circular letter of January 17th. Reference to this letter was made in the last issue of THE ENGINEER. The position, Mr. MacDonald went on to say, remained as stated by the President of the Board of Trade in his reply and supplementary answers to questions on December 11th last. The Government had not been approached by the Cunard Company, but if an approach was made careful consideration would be given to any proposals which might be put forward. The Government could not, however, undertake to give direct financial assistance in that case. The meeting of trade unionists connected with the shipbuilding and allied industries which was held at Clydebank on Thursday of last week, January 28th, ended in disorder, and the resolution urging the Government to reconsider its previous decision and to take steps immediately to assist financially an early resumption of work on the vessel was not passed, an amendment being proposed by interrupters who demanded better conditions of labour for those who had been employed on the vessel. A serious aspect of the prevailing depression is the number of out-of-work apprentices, which may lead to industrial difficulties later on. During the year just ended few firms had sufficient work to keep their apprentices employed. Were work on the liner to be restarted, there is no doubt that valuable experience would be gained by many apprentices in John Brown's works, and at other Clyde establishments associated with the building of the ship.

Television and the Cinema.

IMPORTANT developments regarding the future of television in Britain have taken place during the last few days. The president of the Gaumont British Film Group has secured control of Baird Television, Ltd., by the purchase of 800,000 Baird deferred shares, and progress in the development of television is to be accelerated. For several years Mr. J. L. Baird has been experimenting with a view to adapting television to the needs of the theatre and cinema audiences, and the union of the interests concerned opens up the prospect of displaying contemporary events on screens throughout the country by the transmission of television images from one central receiver. The carrying out of laboratory experiments on an extensive scale is to be encouraged, and Mr. Baird expects to have greatly improved facilities for his work. There will be no substantial alterations in the *personnel* of the television staff, many members of which have been working with Mr. Baird for years and are said to have an unrivalled knowledge of the technicalities of the work. From time to time Mr. Baird has provided the newspapers with rather sensational news, such as that of having transmitted images across the Atlantic, and on Monday last he gave a demonstration of television on a train whilst travelling at speeds up to 70 miles per hour between Sandy and Huntingdon. Even at the highest speed a dancer at the Baird studios in Longacre is said to have been clearly seen. One of the London and North-Eastern Railway express trains is already equipped to receive wireless sound programmes, but this was the first occasion on which a television programme was picked up on a moving train.

The Engineers' German Circle.

THE inaugural meeting of the Engineers' German Circle, which was held at the Institution of Mechanical Engineers on Monday last, February 1st, was successful in every way, and close upon one hundred members and friends attended. After the Chairman, Dr. S. J. Davies, had briefly explained the origin of the Circle and its objects, Mr. Loughnan Pendred spoke on behalf of the Institution of Mechanical Engineers and, as immediate Past-president, welcomed on behalf of the President and Council those present. Mr. Pendred stressed the value of foreign languages to the engineer-salesman, and expressed the hope that the Circle would have a career of increasing usefulness. Mr. Montgomery, assistant secretary, then read a message of greeting from Lieut.-Colonel Kitson Clark, after which the Chairman called upon Herr E. H. Rüter, First Secretary of the German Embassy, to address the meeting. Herr Rüter, in a thoughtful speech, assured the Circle of the keen interest of His Excellency the German Ambassador and his staff, and their readiness to assist the work in any way in their power. Director E. Kocher spoke on behalf of the Verein deutscher Ingenieure, and mentioned that an Engineers' English Circle would be shortly started in Berlin. A lecture was then given by Herr Ingenieure Ernst Schneider, who represents in London the interests of the Maybach Motorenbau, of Friedrichshafen. He described the development and applications of quick-running internal combustion engines, as applied to air, railway and sea transport. The lecture was interspersed with excellent lantern slides, and particular interest was taken in the new express rail-car for the Berlin Hamburg service of the German State Railway Company, which is equipped with Maybach engines and has a designed maximum speed of 100 miles per hour.

A Fast Cross-Channel Motor Ship.

A SUM of 7,500,000f. has been set apart by the Belgian Government this year for the construction of a new ship, to take the place of the "Stad Antwerpen" on the Dover-Ostend cross-Channel service. The order for the new vessel, which will be propelled by Sulzer engines, has been placed with the Société Anonyme John Cockerill, of Hoboken. She will be completed and ready for service in about two years' time, and will probably be named the "Prince Baudouin." She is stated to have a designed speed of 23½ knots, which will make her the fastest motor ship in the world. The exact type of engine has yet to be decided upon, but we are given to understand that supercharging will be considered, and that the probable maximum horse-power will be about 17,000 on twin screws. In view of present industrial conditions in Belgium, it is likely that the main castings for the engines will be made by Messrs. Cockerill's, while some of the more specialised parts will probably be supplied by the Compagnie de Construction Méchanique Procédés Sulzer, of Paris. The choice of a motor ship for this fast cross-Channel service is an event of interest, especially in view of the successful operation of such ships on the Belfast-Liverpool, Esbjerg-Harwich and Bergen-Newcastle services.

The Sunken Submarine M 2.

THE search for the missing submarine "M 2," which never flagged after the loss of the submarine was reported on the afternoon of Tuesday, January 26th, was rewarded on Wednesday night last. Shortly after eleven o'clock an Admiralty announcement was made stating that the Rear-Admiral, Submarines—Rear-Admiral C. J. C. Little—reported that he had located submarine "M 2" at a position approximately 50 deg. 31·2 min. N., 5·8 miles from Portland Bill. She is lying in about 18 fathoms of water and strong undercurrents make salvage work difficult. The position at which the vessel has been discovered is not far from that indicated by Captain E. E. Howard, the master of the Newcastle steamer "Tynesider," who, it will be recalled, reported at Portland that he had seen a submarine submerge stern first in West Bay. A revised list shows that sixty officers and men were aboard the submarine. Immediately the "M 2" was located, preparations were made for the dispatch of the lifting lighter "Moordale" and other salvage craft. The divers investigating the wreck experienced a considerable amount of undertow, which impeded their operations. It is expected that an attempt will be made to lift the ship and to transfer her into shallower water.

A Business Forecast.

THE march of events, says the *F.B.I. Business Barometer*, leaves little doubt that the abandonment of the gold standard by Great Britain on September 21st, 1931, marks a turning point in the world's economic history. The "post-war" international gold standard has permanently broken down, and it can be safely predicted that it cannot be restored in its previous form. The task, therefore, is no longer to recover from a world trade cycle slump of unexampled severity, but to reconstruct and reorganise international commerce and finance on a fresh basis. Heavy losses will have to be borne and drastic reorganisations undertaken, and in the process local inflations may raise local prices. War debts and reparations form a part only of this general salvage work, which is fundamentally commercial and financial in origin. The preoccupation of the coming decade will be to rebuild on the national structures which survive, a system more in tune with the world's natural evolution and the temperaments of its peoples. This new system may perhaps take the form of a reversion to the firmer foundations of pre-war experience with its organisation of countries into more or less independent and self-contained entities or inter-trading groups, loosely linked together internationally for the purpose of ensuring a measure of international stability and concord. So far as Great Britain is concerned, the new era is in process of being born. The nucleus of the new "sterling" group already exists. A comprehensive tariff system, coupled with arrangements for Empire co-operation and commercial agreements with selected countries, will help to consolidate it.

The Erosion of Steam Turbine Blades.

By F. W. GARDNER, B.A., A.M. Inst. C.E.

No. I.

THE history of the steam turbine is a record of rapid development, and inevitably with each advance new problems have arisen. Frequently the difficulties result from unexpected causes, quite unforeseen by the designer. Blade erosion is a problem of this nature, which has recently been brought into great prominence by advances in peripheral speeds.

Increases in speed have always been made with caution and due regard to all the known factors. Careful consideration has been given to the rotational stresses in the blades and the possible effects of vibration. To keep these within safe values as the size of the machines increased, stronger materials were introduced; tapering of the blades was adopted and more adequate means of supporting them against vibration were devised, thus enabling higher speeds to be employed up to a point where an entirely unexpected limitation was introduced by the rapid deterioration of the exhaust end blading under the action of the water of condensation. Blade erosion of essentially the same type was, of course, not previously unknown, but its true nature had not been understood. Its importance was not therefore appreciated until a stage was reached at which erosion occurred so rapidly in service as to suggest that it might prove to be the limiting factor retarding progress in design.

Since that time much work has been done and much experience gained, both in commercial operation and by prolonged research with experimental apparatus. These articles are intended to give a brief account of some of this work, and to describe the development of a method of blade protection which promises to provide the most effective means of controlling erosion and of ensuring a reasonable life for the exhaust end blades at the highest speeds which commercial considerations make it desirable to adopt.

Erosion in one form or another is a problem that engages the attention of the designer in almost every branch of engineering, and the term has commonly been applied to a number of different effects, or rather to describe an effect without special regard to the causes which produce it. Thus, in its widest sense, the word "erosion" denotes a wasting away of the material of a structure under the continued action of fluid flowing past or against it. In a great many cases the wastage is due entirely to a chemical action, and when this is so the term "corrosion" is appropriately employed. Still more frequently it is due to a combined chemical and mechanical action. This effect also is more properly referred to as "corrosion," because in such cases the chemical action is the essential factor and mechanical action merely influences the rate at which wastage proceeds. The fluid scrubs off the products of corrosion and exposes a fresh layer of the original material to the corrosive action. The products are washed away because they are softer than the original material, and in the absence of chemical action the surface would be unaffected by the flow of the fluid. In other cases, the wastage results from a purely mechanical action; that is, by the disintegration of the surface layer of the material into minute particles without any chemical change whatever. It is usual nowadays in mechanical engineering practice to limit the application of the term "erosion" to this type of action.

Confusion frequently results from a failure to discriminate between corrosion and erosion effects, and it is important that the distinction should be clearly understood. True erosion, as defined above, can only be produced when the stresses set up by the impact of the fluid are of such magnitude as to cause rupture of the surface layer of the material. Such stresses must therefore be of a high order of intensity, but are usually extremely local in their action, and the disintegration that results is the cumulative effect of repeated application. For example, pump impellers, water turbine runners and ships' propellers may be cited as familiar cases in which such conditions are frequently met with and are attributable to the water-hammer action produced by cavitation. The distinction between corrosion and erosion is especially important in the case of steam turbine blades, because it is not infrequent to find both phenomena occurring side by side in the same machine and producing effects on the blades to all appearances very similar.

Consideration of the conditions resulting in blade wastage where chemical action is a primary factor lies outside the scope of these articles. Materials possessing a very high degree of resistance to corrosion are now available for the blades, and the refinements introduced into the feed-water equipment of the power station of to-day have set a high standard for the purity of the feed. It is seldom that a case comes under notice where the steam contains corrosive impurities in quantities sufficient to cause serious or unduly rapid deterioration of modern materials. The prevention of blade corrosion, therefore, does not present quite such a difficult problem as erosion, since the latter action involves mechanical principles fundamentally connected with high speeds of rotation.

THE NATURE OF BLADE EROSION.

In that portion of a steam turbine where the expansion is below the saturation line, water separates out from the steam during its passage through the blades or nozzles. The water collects into droplets on suitable nuclei, and the droplets accumulate on the surface of the blades to form drops of varying size. The water drops formed in this way on a stationary blade are not accelerated with the steam. The velocity they can attain from the combined effect of the pressure drop and the drag of the steam jet is small, and they are therefore thrown off from the exit edge of the blade with a comparatively low velocity. Some of them pass on until they are struck by the blades of the succeeding moving row, the velocity of impact

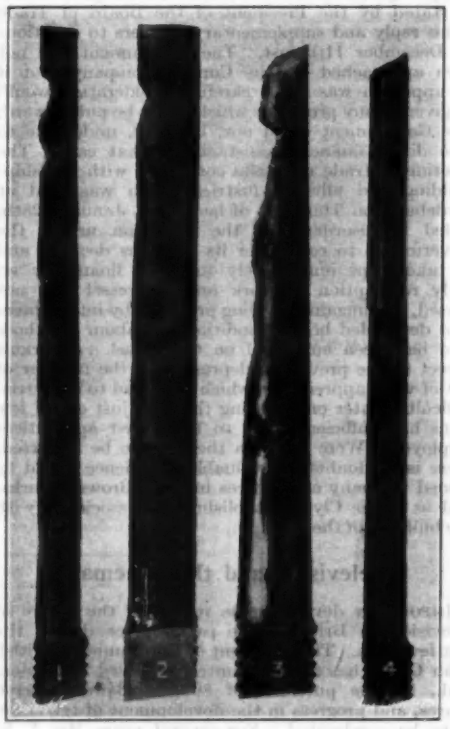


FIG. 1—ERODED LAST ROW BLADES

approximating to the rotational velocity of the blade. If the velocity is high the force of the impact may be great enough to cause a local deformation of the metal, and as the leading edge of the blade is exposed to a constant repetition of such blows, the surface gradually disintegrates. In process of time as the action continues, the metal may be worn away to a considerable depth.

A number of eroded last-row blades are shown in Figs. 1 and 2. They are examples of particularly severe erosion chosen to show the nature of the action and its extreme effect, and a brief review of their history will be of interest. The blades are not all shown to the same scale, as they have been reduced to a uniform size for convenience of reproduction, but to give a clearer idea of the extent of the erosion, full-size drawings of the cross sections of the blades near the tip are given in Fig. 3. The numbers in this figure correspond with those in Figs. 1 and 2.

An interesting case is shown by blade No. 1. It will be seen that the erosion is concentrated at five sharply defined points, nearly equally spaced along the length of the blade, though the extent of the erosion at the three points nearest the root is quite small compared to that at the other two. The leading edge of the blade between these patches of erosion is absolutely unaffected. The preceding guide blades were stayed by five rows of binding strip, and the five points of attack on the revolving blades were unmistakably related to these five strips. It was quite evident that the latter served to concentrate the water. In addition, there was a step in the casing which was in line with the first binding strip,

FIG. 2—ERODED LAST ROW BLADES

so that the effect of these two combined to produce the deep indentation nearest the tip of the blade.

The surface speed in this case was just below 900ft. per second, so that it was not particularly high, but the superheat of the steam supply was low, and consequently the moisture content at the exhaust was exceptionally high. Also the steam conditions were not very good, and as the blades were of mild steel the possibility of corrosion having had some effect cannot altogether be ruled out. The blade when photographed had been in continual service for eighteen months, though its condition then did not differ very materially from that after six months' operation. This is an example of the slowing down of the action that occurs in all cases, and will be referred to again later. After eighteen months the row was rebladed, although the original blades were still mechanically quite sound. This was done for the purpose of testing out protective methods. The replace blades have now been in service nearly six years.

Blade No. 2 is a somewhat similar case where the erosion occurs in patches corresponding to the binding strip. It is of interest because after eighteen months' service the blades already eroded to the extent shown had their leading edge renewed and protected without removing them from the spindle. They have been in service for four years since this was done. The method adopted is explained in a later article of this series that deals with the prevention of erosion. Reference to blade No. 4 is also made in that section.

No. 3 illustrates an extreme case of erosion; the turbine in this case was a 3600 r.p.m. machine with a peripheral speed of 1000ft. per second. The blades were 13in. long, and, as will be seen from Fig. 3, were tapered to an exceptionally thin section, only $^{3}/_{32}$in. at the thickest point. As it was realised that they had been designed without regard to probable erosion, a set of replace protected blades was made before the machine was first started up, and was on site ready for fitting. It is worthy of note that the original blades actually remained in service for nearly two years before they were replaced. In this case, too, the steam conditions were such as

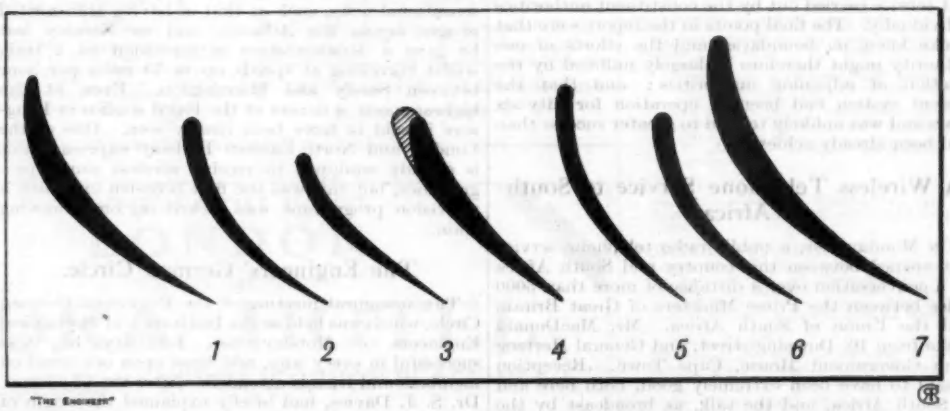


FIG. 3—SECTIONS OF BLADES, FULL SIZE

to give an exceptionally high water content at the exhaust.

Other similar examples are furnished by blades Nos. 5, 6, and 7—Fig. 2—which are all unprotected mild steel blades, photographed after four or five years' service. The erosion is in all cases of the same general type. Blades in turbines with conical casings are affected a little differently from those in the older type of stepped casing. In the latter a very pronounced local indentation correlated with the casing step occurs an inch or two away from the tip, whilst the tip itself is immune. In the former the tip is washed away and the indentation lower down the blade is not localised in the same way, and is consequently less pronounced. An indentation an inch or two from the tip is, however, clearly discernible in all the figures. It is not easy to find an entirely satisfactory explanation of this peculiarity.

Reference has been made to the fact that erosion in a turbine is due to the high velocity of the blade and not to that of the water. The reason for this will be clear from Fig. 4, in which a typical example of the last stage blading of a reaction turbine is shown

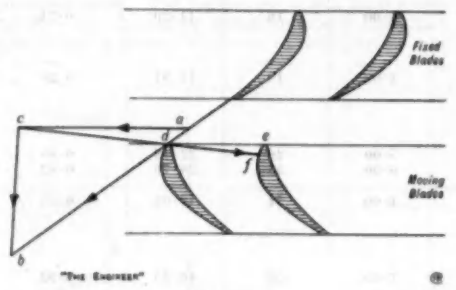


FIG. 4

diagrammatically, and in which velocity triangles for the relative motion of steam, water, and blades have been drawn.

The steam issues from a fixed blade with a velocity represented by $a\,b$. This compounded with $a\,c$ which represents the circumferential velocity of the blade, gives a relative velocity $c\,b$, the direction of which is more or less axial, and the inlet angle of the moving blades is arranged to suit this direction, so that the steam may enter without shock. Water as it reaches the exit edge of the fixed blades is brushed off by the steam stream from which it derives a small velocity that may be represented in the plane of the diagram by the line $a\,d$. In addition, it may or may not have a radial velocity. The resultant of $a\,d$ and $a\,c$ is $c\,d$, which therefore represents the relative or impact velocity of the water and the blade. It will be seen that it is nearly equal to the blade velocity, and is inclined to its direction at a small angle, usually of the order of 5 deg. If $d\,e$ is the blade pitch and $c\,d$ is produced to strike the profile of the adjacent blade at f, then $e\,f$ is the only portion of the blade surface which is exposed to bombardment. Erosion is found therefore to occur on the convex side of the blade, and is initially confined to a comparatively small area at the inlet edge.

The line $a\,d$ as drawn in the diagram indicates a water velocity in the same direction as the steam jet, but only a fraction of its magnitude. It is intended to represent the motion, not of the whole of the water, but rather of that portion which is instrumental in producing erosion. It is in all probability a very small proportion of the total amount of moisture present that is in any way concerned in this action. The velocity of the water will depend on the precise point in the passage through the blade at which it separates out. That which results from condensation near the outlet of the fixed blades, where the steam has already attained considerable velocity will continue to move with the steam in the form of fine mist, and will have a velocity comparable to that of the steam. It will therefore enter the moving blades almost without shock. Drops formed near the inlet of the fixed blade, however, will flow along the blade surface to the exit edge where they hesitate momentarily, as they come under the influence of the slight eddy which always exists there, before they are carried on by the steam. Although the acceleration is large, the velocity they have attained by the time they reach the rotor blades is small compared to that of the steam itself. The magnitude of this velocity can be inferred from an examination of affected blades; that is, by measuring the width $e\,f$, and drawing the diagram in the reverse order.

As the water velocity depends on the distance between the fixed and moving rows, varying approximately as the square root of this distance, it appears that the impact velocity, and with it the amount of erosion, can be influenced by the axial pitching of the blading.

The precise motion of the water in an actual turbine is necessarily, to a large extent, a matter of conjecture, but a good indication of the conditions can be obtained by direct observation of a simple experiment, in which steam or air is blown through a group of blades into the atmosphere. If drops of liquid are introduced at the inlet side, their behaviour on leaving the blades may be watched. Using mercury as the liquid in steam at atmospheric pressure, reproduces the condition of water in a 27·5in. vacuum, with the same jet velocity. With water as the liquid, the conditions may be approached by reducing the velocity of the jet. This experiment leads to the conclusion that the water is discharged from the blades in a very finely divided state, and the drops which cause erosion must therefore be extremely small, a result which may also be arrived at by calculation, as sufficient data are available to enable the drop size to be estimated with very fair accuracy. It also appears that even in a high vacuum the effect of gravity, though not quite negligible, is small for these fine drops, so that the direction of their motion will correspond closely with that of the steam.

In a pure impulse turbine, the diagram of Fig. 4 will be modified, because the velocity of the steam jet leaving the nozzle will be greater than $a\,b$. The effect of this will be to increase the water velocity $a\,d$ and reduce the impact velocity $c\,d$, but as the whole of the expansion takes place in the nozzle the amount of condensation will be greater. Actually the modern high-speed impulse turbine employs a considerable amount of reaction in its last stage, and its diagram is not greatly different from that of Fig. 4.

The tendency all through the turbine will be for the water to travel out towards the casing under the influence of centrifugal force. The bore of the casing will be covered by a film swirling round with considerable velocity imparted to it by the rotor blades. The same action will maintain a greater density of water drops in the outer portion of the blade annulus. The individual drops will, however, only acquire a radial velocity due to this if they traverse a considerable arc between the starting point and the point of impact, and this will not usually be the case. A radial component may result from the general outward direction of the steam flow since in most turbines the blade tip diameter increases rather rapidly at the exhaust end.

An examination of blades in which patches of erosion can be correlated with some definite feature of the preceding stationary blade, such as a binding strip, does in some cases indicate an appreciable radial component, but probably in such cases this radial velocity is directly connected with the disturbance of the flow caused by the binding strip and is therefore localised at that point. As it does not affect the relative velocity normal to the blade surface, the radial component has no direct bearing on the rate of erosion, but it does affect the position on the blade length where the erosion appears.

It has been explained that erosion is confined to a small area on the leading edge of the blade. If all the blades in a row are truly in line, all will be marked to the same extent; if, however, the alignment is not exact the proud blades will partially protect the shy ones, and in so doing will be exposed to an increased intensity of bombardment themselves. It is sometimes possible in a turbine which has only had a few hours' running to pick out some blades on which visible erosion has already taken place in this way. It has been proposed to make some of the blades in a row, say, every tenth, of special design with snouts projecting so far beyond the rest of the blades that the latter would be completely sheltered. The special blades would then take all the punishment, while the rest of the row would be immune. One difficulty in the application of this proposal is that with the high-speeds of the present day, erosion may occur so rapidly that if concentrated on a few blades they would soon disappear. It is better in the end to distribute the wear evenly over all the blades. If some blades are proud of their neighbours, their edges are eroded back till they are level with the rest of the row. As the action continues, the edge of the whole row is worn away, and the erosion limit line—f in Fig. 4—creeps back across the blade section till eventually a deep indent is made.

It might naturally be assumed that in the course of time this action would proceed so far that the blades would be completely cut through. In point of fact, this does not occur. The action is most rapid when the machine first goes into service, and as the indentation proceeds, its progress becomes steadily slower, until it finally becomes stationary, indicating that the erosion has practically ceased. Thus a blade may show after twelve months in service less than twice the depth of indent that appears at the end of the first month, or, as in the case of the first example of Fig. 1, practically no more after eighteen months than at the end of six. Just why this is the case is not very certain, but it is probably attributable to the cumulative effect of a number of small factors. For example, the thickness of the blade section increases, the angle made by its surface with the line of impact alters, and the water has a longer path in which to acquire velocity from the steam.

The primary factors on which the rate of erosion depends are the material of the blades, their velocity, and the quantity of water which strikes them. There are other factors also which exert an influence, notably the vacuum in the turbine at the point in question and the percentage of air or other non-condensable gas in the steam. These factors both have reference to the cushioning effects that may protect the blades from the full force of the impact. If some of the energy of the impact is absorbed in compressing an intervening layer of vapour, the maximum impact pressure will never be reached. It will be shown that the erosive action concentrates on pits in the surface and a pit would form a favourable position for a vapour cushion. The higher the vacuum the less will be the cushioning effect. The presence of air in an entrapped cavity prevents sudden collapse, and is therefore an effective cure for cavitation. In water turbines cavitation or "crackling" is frequently avoided by the simple expedient of admitting air to the tail race. This method is unfortunately not available as a cure for erosion in steam turbines. There is a further reason why the vacuum influences the rate of erosion. Reference to the diagram in Fig. 4 shows that the effect of the absolute velocity of the water is to reduce the impact velocity somewhat below the rotational velocity of the blade. In the case considered, this reduction amounts to some 10 per cent. The water velocity is produced by the drag of the steam, and this drag is proportional to the density of the steam. In consequence, an increase of vacuum means less acceleration of the water and the relative velocity approaches nearer to the blade speed.

If the load on a turbine be reduced, a corresponding reduction in the rate of erosion is to be expected because a reduced load means not only a better dryness factor, but also a reduced quantity of steam, so that the total quantity of water striking the blades comes down rapidly with load, and more than offsets the contrary effect of vacuum, which will ordinarily be higher at a lighter load.

As the vapour density is lowest at the last row, where also there is the most water and the highest blade velocity, it is natural to expect that erosion will be much more violent on the last row than on the preceding rows in a turbine operating at a high vacuum. This, in fact, is always the case—that is, where the blades are all of the same material. It is seldom that erosion is noticeable on more than three rows or stages, and where it does occur on as many as three rows, it is always so much more severe on the last stage as to make that on the others appear insignificant by comparison. Cases could be cited where an apparently similar action has been noted extending further up the turbine, but in such cases the action is not true erosion, but is the result of a combined effect originating primarily in corrosion in the manner explained earlier in this article.

(To be continued.)

Institution of Mechanical Engineers.

AT last Friday's meeting of the Institution of Mechanical Engineers in London, Mr. J. D. Twinberrow presented before a crowded audience a paper entitled "The Mechanism of Electric Locomotives." We begin a reprint of this paper elsewhere in to-day's issue.

Before Mr. Twinberrow was called upon to present his paper, the President, Lieut.-Colonel Kitson Clark, announced that the Council had that day elected as an honorary life member Sir Joseph Thomson, Master of Trinity College, Cambridge, and Cavendish Professor of Experimental Physics. Honorary life membership had also been conferred upon two of the Institution's Past-presidents, Sir Vincent Raven and Sir Henry Fowler. Colonel Kitson Clark further intimated that the Council had nominated as President for the ensuing year Mr. William Taylor, and that Colonel Davidson, Mr. Gresley, and Mr. Maunsell had been nominated as Vice-presidents. Mr. Maunsell was appointed a vice-president by the Council to fill the vacancy caused by the death of Sir Archibald Ross on March 16th, 1931.

Mr. F. Lydall, opening the discussion on Mr. Twinberrow's paper, said that in the early days it had been justifiable to assume that the details of established steam locomotive practice would be applicable to electric locomotives. Speeds and tractive efforts had, however, since increased. To-day, in the United States, a single electric locomotive was required to haul 1000 tons at 90 m.p.h. on the level. To fulfil that duty it had to be capable of developing 3750 H.P. In that locomotive the mechanical problems presented for solution were more difficult than the electrical problems. He would like to know why the Paris–Orleans gearless electric engine mentioned by the author had proved unsatisfactory at high speeds. Similar locomotives were working satisfactorily at equally high speeds in the United States. In America a preference was shown for the quill spring drive. The objections to that form of drive referred to by Mr. Twinberrow had now practically been overcome. A quill spring drive was used in the Pennsylvania electric locomotive to which he had just referred. He desired to know on what actual experience the author based his remarks concerning the beneficial effect on tire wear produced by the articulation of the bogies. On the 5ft. 6in. gauge in India, a locomotive had been run over 22,000 miles without articulation. The tire wear was carefully measured, and had been found to be definitely less than that on a similar articulated locomotive on the same service.

Mr. F. Jackson criticised the author's suggestion that the nose-and-axle suspended motor should be eliminated from all future electric locomotives. The suggestion, he thought, was too sweeping. It might be adopted for speeds of 80 to 90 m.p.h., but many

people would disagree with it as applied to low-speed engines. The author seemed to imply that the gearless locomotive was better than one having its motors suspended in the nose-and-axle manner. The great disadvantage of the gearless type was the low armature speed of the motor, and consequently the great size of the power equipment.

Mr. A. M. C. Hug reported the results of a six months' test of articulated and non-articulated electric locomotives on the Swiss Federal Railways. The wear, he said, was found to be much less on the articulated locomotive than on the non-articulated. The nose-suspended motor was a cheap and interesting solution of the driving problem for engines running at less than 40 to 50 m.p.h., but the elastic suspension of the motor in the frame of the bogie presented several advantages, and did not require more room than the nose-and-axle type of suspension.

Mr. N. A. Lelean said that it might seem ungracious to criticise the beautiful designs described in the paper, but if the electric locomotive were an entire success, why, he asked, had that great authority on all railway matters, Sir Ralph Wedgwood, told the Institution on the previous evening that the steam locomotive still occupied first place? The great desideratum in a locomotive was simplicity. He questioned whether in that respect the electric locomotive was superior to the steam locomotive. Simplicity was of very great importance if the engines had to be driven by natives. There was nothing in a steam locomotive at all comparable with the difficulty of making and maintaining the driving gears for an electric locomotive.

Professor G. Lomonossoff called attention to the fundamental difference between reciprocating steam locomotives and locomotives driven by means of electric motors or turbines. That difference, he said, resided in the fact that the reciprocating steam engine gave a periodically varying torque at the driving axle, while the electric or turbine drive gave a constant torque. As Leonardo da Vinci had discovered, gearing or belts provided a better means of transmitting a uniform torque from one shaft to another than any system of rods and cranks. His own experience with axle-mounted armatures was directly opposed to the views expressed by the author. Studies which he had made on the New York Central Railroad had led him to the conclusion that the nose-and-axle suspended arrangement was superior to the axle-mounting system. With axle mounting, the revolutions of the armature were of necessity equal to the revolutions of the wheel. The motors were, as a consequence, very heavy, and had a tendency to overheat. With geared drives the motors ran at from three to seven times the speed of the wheels.

Mr. G. H. Fletcher also defended the axle-hung motor. If, he said, lateral impact were a serious matter, it could be dealt with by means of resilient axle collars. That plan had, indeed, actually been carried out in practice. With regard to vertical impact, there had not been a single case of failure from that cause among the 400 South African electric locomotives during runs totalling 140 million miles. Concerning the effect on the track, he said that no unusual deterioration had been found on those portions of the line passed over at high speed, but at starting and stopping places the increased acceleration and deceleration achieved with electric locomotives had definitely increased the rate of deterioration of the track.

Mr. E. A. Croft remarked that no one possessed any real evidence to the effect that inside frames were better than outside frames. Concerning articulation, he said that evidence was accumulating that it was wrong and unnecessary.

The President having raised a question concerning the safety of spring drives, Mr. Twinberrow, in the course of a brief reply to the discussion, admitted that trouble had been experienced with them on the G.I.P. railway. Such drives, he said, might be suitable for single-phase locomotives, but they were possibly less suitable for direct-current locomotives. In India, after service on runs totalling 100,000 miles, the spokes in the wheels of spring-driven locomotives showed signs of beginning to fail by fatigue. Cracks were detected, but fortunately the trouble was discovered before a serious accident occurred.

The annual dinner was held on Thursday, January 28th, at the Connaught Rooms, London. About 350 members and guests attended it. The toast of "The British Commonwealth of Nations" was proposed by Mr. A. E. L. Chorlton, Vice-president, and was responded to by Major-General Sir Granville Ryrie, High Commissioner of the Commonwealth of Australia, and by Mr. Herwald Ramsbotham, Parliamentary Secretary to the Board of Education. "The Guests," proposed by Mr. William Taylor, Vice-president and President-nominate, was acknowledged by Sir Ralph Wedgwood, and by Lieut.-Colonel G. P. Vanier, secretary, Canada House. Sir Alfred Ewing proposed "The Institution," to which the President, Lieut.-Colonel Kitson Clark, responded.

A NEW Junkers aeroplane has been installed at Winnipeg, Manitoba, for freight service. It is equipped with a 685 horse-power engine and has a cruising speed of 100 miles an hour. It can carry 2 tons a thousand miles without refuelling.

British and American Rolled Steel Sections.

By B. L. HURST, M. Inst. C.E., M.I. Mech. E., M.I. Struct. E.

A REVISED list of British Standard Channels and Beams has just been published by the British Standards Institution.

It will be remembered that when the 1924 revised list of Standard Sections was issued they were expected to supersede the rather heavier sections then in existence. The claims, however, of a large number of the original sections are such that they are in considerable demand to-day and their supersession by the newer sections would be both unpopular and inadvisable. In addition, a number of the newer sections have achieved a well-deserved popularity.

It will be obvious, therefore, that while the British Standard List issued in 1924 added something to the efficiency of steel construction on the design side, the benefits due to standardisation were in part negatived. Thus, with the larger number of sections then available, specifications tended to cover a larger range than was economically desirable, impairing efficiency by increasing the amount of roll changing, by delaying deliveries and by adding to the capital tied up in the stock of the necessary rolls.

The new list which is published regularises the position. Only a few of the sections—namely, the 11in. by 3½in. and the 13in. by 4in. channels and the 24in. by 7½in. by 95 lb. beam are entirely new, the list otherwise comprising a combination of the original and revised sections, with all those others which are seldom required, or are otherwise redundant, omitted.

It is expected that once the old rolls are worn they will be definitely discarded and that the new list will be adhered to by all who roll and use steel sections. This concentrated, yet comprehensive, range of sections will achieve the dual purpose of providing the steel maker anew with the full benefits of standardisation, while the user is assured that his requirements for all structural purposes will be adequately met.

To those who regard any reduction in the number of sections at present available as a retrograde step, investigation will show that the new list within its present range offers little scope for criticism. It is perhaps not fully appreciated even in this country how favourable the comparison is between British Standard Sections and those of other countries. This new list of beams, comprising forty sections between 3in. and 24in., on which those responsible for its compilation under the auspices of the British Standards Institution are to be congratulated, is of

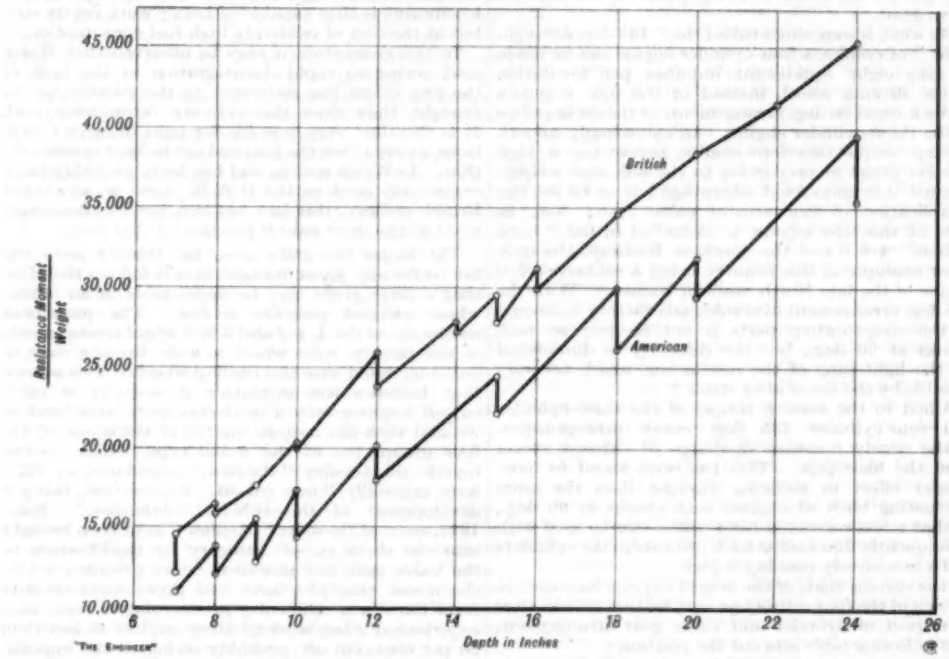
COMPARISON OF EFFICIENCIES OF AMERICAN AND BRITISH STANDARD STRUCTURAL BEAMS (B.S.I.).

	U.S. STANDARDS.				B.S. STANDARDS.			
Depth, in.	Width of flange, in.	Weight per foot, lb.	Section modulus, in.³	Efficiency. section modulus / weight per foot.	Width of flange, in.	Weight per foot, lb.	Section modulus, in.³	Efficiency section modulus / weight per foot.
7	3·66	15·3	10·34	0·68				
					4·00	16	11·29	0·71
	3·76	17·5	11·11	0·63				
	3·86	20·0	11·97	0·60				
8					4·00	18	13·91	0·77
	4·00	18·4	14·22	0·77				
	4·08	20·5	15·05	0·73				
	4·17	23·0	16·05	0·70				
	4·26	25·5	17·02	0·67				
					5·00	28	22·42	0·80
					6·00	35	28·76	0·82
9					4·00	21	18·03	0·86
	4·33	21·8	18·87	0·87				
	4·44	25·0	20·31	0·81				
	4·60	30·0	22·53	0·75				
	4·76	35·0	24·73	0·71				
					7·00	50	46·25	0·93
10					4·50	25	24·47	0·98
	4·66	25·4	24·42	0·96				
	4·80	30·0	26·70	0·89	5·00	30	29·25	0·97
	4·94	35·0	29·16	0·83				
	5·09	40·0	31·60	0·79	6·00	40	40·96	1·02
					8·00	55	57·74	1·05
12	5·00	31·8	35·97	1·13				
					5·00	32	36·84	1·15
	5·08	35·0	37·83	1·08				
	5·25	40·8	44·82	1·10	6·00	44	52·79	1·20
	5·36	45·0	47·35	1·05				
	5·48	50·0	50·27	1·01				
					6·00	54	62·63	1·16
	5·60	55·0	53·22	0·97	8·00	65	81·30	1·25
13					5·00	35	43·62	1·25
14					6·00	46	63·22	1·37
					6·00	57	76·19	1·34
					8·00	70	100·80	1·44
15					5·00	42	57·13	1·36
	5·50	42·9	58·91	1·37				
	5·54	45·0	60·48	1·34	6·00	45	65·59	1·46
	5·64	50·0	64·15	1·28				
	5·74	55·0	67·83	1·23				
	6·00	60·8	81·20	1·34				
	6·08	65·0	84·28	1·30				
	6·18	70·0	87·95	1·26				
	6·28	75·0	91·63	1·22				
16					6·00	50	77·26	1·55
					6·00	62	90·63	1·46
					8·00	75	121·74	1·62
18	6·00	54·7	88·39	1·62				
					6·00	55	93·53	1·70
	6·09	60·0	93·09	1·55				
	6·17	65·0	97·53	1·50				
	6·25	70·0	101·94	1·46				
					7·00	75	127·91	1·71
	7·00	75·6	126·87	1·68				
	7·07	80·0	130·76	1·63	8·00	80	143·56	1·79
	7·15	85·0	135·18	1·59				
	7·24	90·0	139·61	1·55				
20					6·50	65	122·62	1·89
	6·25	65·4	116·95	1·79				
	6·32	70·0	121·42	1·73				
	6·39	75·0	126·35	1·68				
	7·00	81·4	146·63	1·80				
	7·05	85·0	150·17	1·77				
					7·50	89	167·29	1·88
	7·13	90·0	155·03	1·72				
	7·20	95·0	159·97	1·68				
	7·27	100·0	164·83	1·65				
22					7·00	75	152·44	2·03
24	7·000	79·9	173·93	2·18				
	7·063	85·0	180·00	2·12				
	7·124	90·0	185·84	2·06				
	7·186	95·0	191·80	2·02	7·50	95	211·09	2·22
	7·247	100·0	197·65	1·98				
	7·875	105·9	234·30	2·21				
	7·925	110·0	239·10	2·17				
	7·987	115·0	245·04	2·13				
	8·048	120·0	250·90	2·09				

outstanding merit, and comparison with the standard beams of other countries should prove a source of satisfaction to British steel makers and to users of British steel at home and throughout the Empire.

A comparison of the moduli of the various British and American sections was made by the British Standards Institution in the preparation of their list of sections and the increased efficiency was also tabulated. These figures, which are reproduced in the table, indicate that even the most efficient American section for each size of joist is not so efficient as the British section of the equivalent overall dimension. It is not that the British sections are lighter, but that they have a better distribution of metal. This factor is indicated in the efficiency column and reflects better design.

British sections not only show increased efficiency—*i.e.*, an increased section modulus per unit of weight—but have the initial advantage of having a higher ultimate tensile strength than the American sections. On the basis of the American ultimate tensile strength of 55,000/65,000 lb. per square inch, British steel, with an ultimate of 28/33 tons per square inch (62,720/73,920 lb. per square inch) is equivalent to a high-tensile steel. The logical use of this high tensile property—*i.e.*, the higher minimum tensile strength—would ensure a greater economy in construction consistent with security, on the basis of the same factor of safety.



EFFICIENCIES OF BRITISH AND AMERICAN BEAMS OF VARIOUS DEPTHS

American practice in constructional steel work design is to utilise a safe load of 18,000 lb. per square inch, which, based on the minimum ultimate tensile strength of the steel, represents a factor of safety of 3·06. Using this same factor of safety, British sections may with equal security be stressed to 20,500 lb. (9·17 tons) per square inch.

With this outstanding advantage, combined with the increased efficiency of the section, the British product is at least 13 per cent. superior to the American. These factors have been combined and are shown very clearly in the accompanying graph, in which the ordinates represent efficiency—resistance moment divided by the weight—and the abscissæ represent the depth of the various beam sections in inches. Where two or more sections are rolled of the same overall depth, the maximum and minimum efficiencies have been plotted. The comparison is conclusive, it is clear, it is logical, and as both graphs are based on the same factor of safety it is a correct comparison.

All the British Standard beam sections over 6in. have been used in the comparison, only the broad flange beams which are specially designed as stanchion sections have been omitted.

The argument is frequently advanced in favour of certain American sections that they have a very desirable lightness, having very thin webs. To the engineer, however, the only true basis of comparison is the load-bearing capacity, and in any case engineers in this country have definitely set their face against excessively thin webs as reducing the factor of safety under all conditions of service.

There is another aspect which is frequently overlooked, and that is the shear value of the section. The shear value of the larger sections may be of paramount importance in the design, and the use of a slightly heavier section as a plain beam may obviate additional fabrication in stiffening the web.

American practice in rolling various web thicknesses for one particular depth of beam may seem to be the logical solution, but the possibility of error through improper use of the section is greatly increased. For instance, there are nine standard variations for the 24in. beam with weights ranging from 79·9 lb. to 120 lb. per foot. The first five of these sections have a variation in web thickness of only $\frac{1}{16}$in., and if we consider normal rolling tolerances, the variation upwards and downwards of $^1/_{32}$in. would wipe out the difference between any two sections. This concentrated range of sections may seem to meet all requirements, but the general consensus of opinion here would be that it unnecessarily complicates the position and increases the cost of production and the risk of error in construction.

It will also be noted that the efficiency of the most efficient American 24in. beam is less than that of the new 24in. 95 lb. British beam. Yet it has been stated that where the lighter American section is suitable the nearest British section weighs many pounds per foot more. But by taking advantage of the higher minimum tensile strength the use of the British section 22in. by 7in. by 75 lb. will perform almost equal service, with a saving in weight of 5 lb. per foot and a usually very desirable saving of 2in. in headroom.

British sections have always had a world-wide reputation—a reputation associated with the high quality and reliability of the material. The new revised list can only enhance this reputation. The sections throughout the full range are economical, adequate and commercially desirable. The figures presented in this article emphasise, moreover, that by giving due recognition to the design factor, British sections are pre-eminently superior on a scientific basis to the corresponding products of any other country.

The Trend of British Express Locomotive Design.

By W. A. TUPLIN, B.Sc.

THE chief development of the British express locomotive during the last few years has been in the direction of higher thermal efficiency. This is the result, not only of the desire to reduce coal consumption, but also of the need to obtain greater haulage capacity without appreciably increasing overall dimensions. So far as the conventional type of locomotive is concerned, indeed, no considerable growth would seem possible, within the British loading gauge, though one makes this statement with some hesitation, in view of the regularity with which it has greeted the production of every notably large design during the last thirty years.

The methods by which it is sought to raise the thermal efficiency are :—

(1) By designing the valves and valve gear so that the engine can work at early cut-off.

(2) By raising the boiler pressure.

The first of these appears an elementary essential, but, nevertheless, many locomotives have been constructed in which it is not realised. In recent years more attention has been directed to this point, with the result that the whole trend of locomotive design has been affected.

In the present article consideration is given in turn to (1) valves and valve gear; (2) cylinder arrangements; (3) boiler and fire-box; and (4) wheel arrangements; but it is impossible to make sharp distinctions between these sections, as in the very nature of the locomotive they are all closely related to each other.

VALVES AND VALVE GEAR.

At the beginning of the present century British practice was to use Stephenson link motion in conjunction with flat slide valves, and although it had, of course, long been recognised that working at early cut-off was desirable, care was not always taken to ensure that the design of valves and valve gear was such as to make it practicable.

With the Stephenson gear "linking up" brings the compression point earlier in the exhaust stroke, thus entrapping an excessive amount of steam in the cylinder, and giving rise to considerable back pressure. Also, as the lead is greater at early cut-off, the back pressure is increased by the early admission of live steam before the piston reaches the end of the stroke. Consequently, a piston load corresponding to something approaching full steam chest pressure is transmitted to the crank pin for an extensive portion of its path near the dead centres. The rubbing speed of the big end on the crank pin is higher at the inner dead centre than at any other point in the stroke. In this neighbourhood, therefore, heavy loading and high rubbing speed occur in combination, and the result is a tendency to overheating. Many locomotives, in fact, cannot be worked at early cut-off, for fear of hot big ends.

As the frictional resistance of flat valves makes it impracticable to use a long valve travel, it is difficult to secure adequate port opening to exhaust when "linked up." Further, the necessity for keeping the valve as short as possible, makes the passages between the steam chest and cylinder comparatively long and tortuous, this again increasing the resistance to the passage of the exhaust steam. The use of flat valves therefore tends still further to increase the back pressure which arises with the adoption of an early cut-off.

In these circumstances it was the normal practice not to work an engine at any earlier cut-off than about 30 per cent., the regulator opening being adjusted to suit the effort required at any particular moment.

These remarks refer to the practice of British railways in general, with one exception, the Great Western, which in 1902 set an example which has been extensively followed only in the last five years or so. By using piston valves instead of flat valves, the main objection to long valve travel was removed, and short steam passages of ample cross-sectional area became possible, giving reduced back pressure. Working at early cut-off was thus rendered practicable, and advantage was taken of this to use a high boiler pressure. These features took shape in the early Swindon 4–6–0's for express passenger service, two-cylinder engines, which with slight modifications form the nucleus of the "Saint" class, now numbering seventy-six. One of the series was converted in 1925 into a mixed traffic engine by being provided with wheels 6ft. in diameter instead of 6ft. 8in., and now constitutes the first of the "Hall" class, of which 120 have been constructed since 1928.

The adoption of the piston valve on other railways made comparatively slow progress until the advent of superheating round about the year 1910. The difficulty of lubricating flat valves when using superheated steam then caused the piston valve to spring, somewhat tardily, into popularity, and it is now almost universally used.

By the adoption of the compound principle, the virtues of early cut-off working can theoretically be obtained without incurring excessive back pressure, but actually, of the very numerous compound systems which have been tried in practice, only one has been perpetuated in this country. That compounding could be made successful on the railway was first forcibly shown by the remarkable work of the "de Glehn" compounds on the Northern Railway of France. After purchasing and testing three locomotives of this type, the Great Western authorities decided, however, that the success of the design was not entirely attributable to compounding, and found that, by the use of the same high boiler pressure as the French engines, a simple engine could be made to give comparable results. The G.W.R. 4–4–2 "North Star," built in 1906, closely resembled the French compounds in everything except their compounding, and could do equally good work. It embodied, in the Walschaerts valve gear, a notable departure from previous general practice in Britain. "North Star" was later converted into a 4–6–0, and as such became the most noteworthy British locomotive of this century. It was the first of the "Star" class, which in 1922 reached the number of seventy-three. The "Castle" class of forty engines, and the "King" class of thirty, are successive enlargements of the "Star" class. On other railways the Southern "Lord Nelson," and the L.M.S. "Royal Scot," the largest express engines of their respective lines, are lineal descendants of the "North Star" of 1906.

The Walschaerts valve gear played no small part in the outstanding success of the G.W. four-cylinder engines. This gear, unlike the Stephenson motion, gives constant lead at all cut-offs, and has less tendency to increased compression when "notched up." Used in conjunction with piston valves and steam ports of ample dimensions, it gives a very low back pressure, resulting in an engine which runs freely even at early cut-off.

The "Stars" may be worked continuously under easy conditions at a cut-off in the neighbourhood of 18 per cent., whereas the "Saints," which have two cylinders of slightly less total volume than the four cylinders of the "Stars," and Stephenson link motion, but are otherwise identical, do not operate satisfactorily at such an early cut-off. It is the practice to run the "Stars" notched up as far as the work required will permit, but to work the "Saints" at a somewhat lower expansion ratio. The advantage of early cut-off from the point of view of increased power is admirably illustrated by the comparison between these two classes, for the "Stars" are able to handle distinctly heavier loads than the "Saints," although the two types carry the same standard boiler pressed to 225 lb. per square inch. For many years these two designs were indubitably the fastest locomotives running in this country, speeds over 80 m.p.h. being attained with moderate loads on level track, whereas little higher than 70 m.p.h. was usually reached by other engines in similar conditions. Even in these days the G.W.R. locomotives are most distinguished for high speed, but they are now closely challenged by those of other lines.

Since about 1913 the Walschaerts valve gear has increased in popularity in this country, until it may now be regarded as standard. The use of outside cylinders, with steam chests placed above them, has no doubt been an important factor in this respect, for the Walschaerts valve gear is peculiarly suited to this lay-out, and with it has the advantage of easy accessibility. The fact that this gear can be designed to permit of early cut-off working has apparently not always been given the attention it deserves.

A more revolutionary tendency which has shown itself in the last four or five years is the adoption of poppet valves on the Lentz and Caprotti systems. Not only do these valves require much less power for their operation than either flat or piston valves, but since the inlet and exhaust valves are independently controlled, an extremely early cut-off may be used without introducing excessive back pressure. Various standard locomotives have been converted from piston valves to Caprotti or Lentz valves, with considerable advantage in the way of coal consumption. In some instances, too, the reduction of back pressure has produced a much more freely running engine.

CYLINDER ARRANGEMENTS.

The use of two inside cylinders, so long characteristic of British practice, is probably the most satisfactory plan for locomotives of moderate power, but difficulties arise when larger dimensions are contemplated. The largest inside cylinders on a British locomotive are 21½in. in diameter, and this represents very nearly the limit with the usual style of plate frame. By the adoption of a special frame construction at the front end, this restriction may be avoided, as is done in the latest Nord four-cylinder compound "Pacifics," whose low-pressure (inside) cylinders are 24½in. in diameter; but it is unlikely that this device will ever be found necessary in this country, unless compounding comes into favour.

Outside cylinders are also restricted in diameter by the loading gauge and are less favourable from the point of view of balancing than inside cylinders, as the greater distance between the cylinder lines increases the swaying couples. In locomotives of moderate size, not intended for high speeds, these objections are not serious. In such cases, the elimination of the crank axle and—with Walschaerts valve gear—the placing of the whole of the motion work in an accessible position outside the frames have made this form of construction popular in later years. In America it is standard practice, even for the largest locomotives, outside cylinders over 30in. in diameter, being in use, but in this country the heaviest express traffic is now handled by engines having three or four cylinders.

When first the need arose for using more than two cylinders, the four-cylinder arrangement found favour as, with the natural arrangement of cranks at 90 deg., two sets of valve gear suffice, operating two valves directly, and the other two through rocking levers. If the moving parts are identical for all four cylinders the balancing is as nearly perfect as can be expected in a locomotive, yet, apart from the Great Western Railway, there is only one British class in which this ideal is attained.

If the cylinders are set in line between the bogie wheels, they may all drive on the leading coupled axle, and the reciprocating parts may be identical. The objection is that the connecting-rods are comparatively short, even when the wheel base of the locomotive is extended to mitigate the difficulty. The "Claughton" class 4–6–0's of the late L.N.W.R. are the only British examples of this arrangement.

If the inside cylinders, driving on the leading coupled axle, are placed between the leading bogie wheels, the outside cylinders, driving on the second coupled axle, come abreast of the trailing bogie wheels, when connecting-rods of equal length are used. The outside cylinders must then be set at wide centres to give clearance for the side movement of the bogie wheels, again introducing loading gauge restrictions. This scheme is, nevertheless, embodied in the G.W.R. four-cylinder engines, though it would seem that the 16½in. diameter outside cylinders of the "Kings" are about the largest that can be accommodated in this position. All other designers have placed the outside cylinders in the normal position abreast of the bogie centre, accepting the slight imperfection in balancing resulting from the unequal lengths of the connecting-rods.

The three-cylinder engine suffered at first from the drawback that three sets of valve gear were required, needing, with link motion, six excentrics. This was, in general, deemed sufficiently serious to counterbalance the undoubted advantage of even torque which it holds over the two and four-cylinder engines with cranks at 90 deg. On the late North-Eastern Railway, however, the opposite opinion prevailed, and from 1909 until that railway became merged into the L.N.E.R., all new designs from Darlington incorporated three cylinders and three sets of link motion.

The introduction, in 1918, of the Gresley mechanism, whereby the motions of the outside valves are combined to give the required movement to that of the inside cylinder, seemed to remove the main objection to the use of three cylinders, but, apart from the late Great Northern Railway, no immediate advantage was taken to develop the three-cylinder engine. On the G.N.R., and later on the L.N.E.R., the Gresley mechanism has been incorporated in a number of new designs, but, on the other hand, the three-cylinder 4–6–0 "Royal Scots," of the L.M.S., are fitted with three sets of Walschaerts valve gear.

By what is sometimes called the "135 deg. arrangement" of cranks, a four-cylinder engine can be made to give eight equidistant impulses per revolution of the driving wheel, instead of the four impulses of the normal 90 deg. arrangement, or the six impulses of the three-cylinder engine. An exceedingly smooth driving torque therefore results, permitting a high tractive effort in proportion to the adhesion weight. Against this undoubted advantage has to be set the complication of four sets of valve gear; but, in spite of this, the scheme is embodied in the "Lord Nelson" 4–6–0's of the Southern Railway, the only other example in this country being a solitary 0–6–0 engine of the late North Stafford Railway. With the 135 deg. arrangement of cranks, satisfactory balancing of the reciprocating parts is not so easy as with cranks at 90 deg., but the difficulty is diminished by the lightening of the mechanism which becomes possible by the use of alloy steels.*

Allied to the smooth torque of the three-cylinder and four-cylinder 135 deg. crank arrangements, is the nearly constant discharge of exhaust steam from the blast-pipe. This has been found to have greater effect in inducing draught than the more fluctuating blast of engines with cranks at 90 deg., so that a less restricted blast-orifice can be used with consequently diminished back pressure in the cylinders and a more freely running engine.

It is curious that, of the largest express locomotives of each of the four railway groups, no two are identical in respect of cylinder and valve gear arrangement. The following table sets out the position:

Railway	Name.	No.	Wheel arrangement.	No. of cylinders.	No. of sets of valve gear.
L.M.S. ..	"Royal Scot" ..	6100	4–6–0	3	3
L.N.E.R.	*"Great Northern" ..	4470	4–6–2	3	2
G.W.R.	"King George V." ..	6000	4–6–0	4	2
S.R. ..	†"Lord Nelson" ..	850A	4–6–0	4	4

* Gresley mechanism. † Cranks at 135 deg.

BOILER AND FIRE-BOX.

Round about the year 1900, there commenced a reaction from a period of "over-cylindering," and the adequate boilers which came to be provided had the effect of encouraging late cut-off working by their ability to supply the steam thus inefficiently consumed. The highest ratio of boiler heating surface to cylinder volume in British practice is attained in the large "Atlantics" of the late G.N.R., this type having been introduced in 1903. At that time the dimensions of the boiler of this class were far beyond those of any other British locomotive type whilst the cylinders were actually smaller than the average of those in general use. Only by working at late cut-off could the full capacity of the boiler be absorbed in the comparatively small cylinders, and thus was instituted a style of operation which was characteristic of the the type, and, to a lesser extent, of the period.

By comparison with modern methods, the less economical procedure of the past may be regarded as "thrashing." Not only is the steam wasted by discharge from the blast-pipe at a comparatively high pressure, but the consequent heavy draught causes the boiler to be worked at an uneconomically high rate unless it be exceptionally large. In this respect, of course, the G.N. "Atlantics" have an advantage; although late cut-off working is necessary because of the small dimensions of the cylinders, the boiler itself is rarely pressed.

The same could not be said of other designs, notably the 4–4–0 engines of the late L.N.W. and G.E. railways, the records of whose performances in hauling heavy express trains make extraordinary reading when compared with the work done by the much larger locomotives employed on similar services to-day. The older engines achieved times and speeds closely comparable with those common with equal loads in modern times, but they did it by dint of "thrashing" at heavy cost in fuel and maintenance.

Against this has to be set the fact that late cut-off working does not demand the highest degree of skill in firing, so that these hard-worked engines were consistent and reliable time-keepers. With the heavy draught induced by high exhaust pressure, a thick bed of fuel must be carried on the grate, or else there is a tendency to tear holes in the fire, admitting cold air to the fire-box, and impairing the steaming of the boiler. The essential is therefore to maintain a thick fire, small variations in thickness being unimportant. On the other hand, the gentle blast associated with early cut-off working will not draw sufficient air through a thick fire to generate heat at the required rate, and it is thus necessary to have a small uniform depth of fuel over the whole of the grate area, and at the same time to avoid the formation of holes.

It will be appreciated that the steaming of an engine working at late cut-off with a thick fire is less susceptible to inexpert firing than one in which a thin fire is made necessary by early cut-off. Conversely, when in skilled hands the boiler may be worked continuously at high rates of evaporation, and the locomotive is thus capable of heavy work for its size, but at the cost of relatively high fuel consumption.

In this connection it may be observed that Welsh coal, owing to rapid disintegration in the heat of the fire, offers less resistance to the passage of the draught than does the ordinary bituminous coal. It is therefore very suitable for light draught conditions, as even then the fire need not be kept excessively thin. As Welsh coal is, and has been, probably more extensively used on the G.W.R., than on any other British railway, this fact has lent further encouragement to the short cut-off practice on that line.

The larger the grate area, the thinner must the fire be for any given draught, and it follows therefore that a large grate may be undesirable in an engine whose exhaust pressure is low. The prominent advantage of the 4–4–2 and 4–6–2 wheel arrangements is the facility with which a wide fire-box may be accommodated over the trailing wheels. This advantage becomes less attractive if working at early cut-off requires only a moderate grate area, and so we find that the largest engines of three out of the four groups are of the 4–6–0 type, whilst on the fourth, the Gresley "Pacifics," introduced in 1922, were originally "late cut-off" locomotives, being a development of the G.N.R. "Atlantics." Since 1927, some of the older "Pacifics" have been brought into the short cut-off category by modification to the valve gear and increased boiler pressure, whilst the newer examples have had these characteristics from the start. Difficulty in steaming is sometimes experienced when working these engines at less than 20 per cent. cut-off, probably owing to the impossibility of maintaining a sufficiently thin fire on the large grate.

It would seem therefore that the wide fire-box is not so desirable as would at first appear. It is significant that the highest thermal efficiencies recorded on British railways have been attained by locomotives provided with narrow fire-boxes, and also that this form of construction is a feature of the Nord "Pacifics," which, for their size, are probably the most capable express locomotives in the world. The advantage of the narrow fire-box may be attributed to the fact that as the ratio of fire-box heating surface to grate area is higher than in the wide type of box, the temperature of the gases entering the tubes is lower and, consequently, for the same tube length, less heat is lost through the chimney. Certainly, the wide fire-box has never been a favourite in this country, even in the days of late cut-off working, to which it is the more suited. It may, however, be forced upon designers if the general dimensions of the express locomotive have to be appreciably increased, as the necessary length of the narrow fire-box tends to make hand-firing exceedingly arduous. The greatest length so far used in this country is the 10ft. on the G.W.R. "Kings," but the Nord "Pacifics," also hand-fired, surpass this with 11ft. 6in. In these, and in most other narrow boxes, the front portion of the grate slopes downwards, and this certainly assists the fireman's work.

So far as working pressure is concerned, it is noticeable that for a period of about twenty years the average figure was in the neighbourhood of 180 lb. per square inch. This was, of course, a result of late cut-off working. If the steam cannot be expanded in the cylinder to a correspondingly greater extent, there is little advantage to be gained from increased pressure. On the contrary, boiler upkeep becomes heavier. With improved steam distribution in the cylinders, however, working pressures began to increase, and since 1927 the largest engines of two lines have been working at 250 lb. per square inch., and those of the other two at 220 lb. per square inch. On the G.W.R. the working pressure of the 4–6–0 engines had been 225 lb. for more than twenty years previously. Boiler pressures up to 275 lb. are common in America, but this figure is usually regarded as approaching the economic limit for a boiler of the conventional type.

* The balancing of the Lord Nelson was discussed in THE ENGINEER of November 19th, 1926, when reference was made to the smallness of the hammer blow resulting from the arrangement adopted.—ED. THE E.

Every modern design of locomotive intended for continuous running embodies a superheater, as only in the shunting engine, whose runs are not long enough to permit of the attainment of any useful degree of superheat, can its economy of fuel and water be denied. Initial difficulties in lubricating the cylinders have long since been overcome, and the superheater may now be regarded as an essential member of the locomotive. The general tendency has been to increase the heating surface of the superheater so as to secure a steam temperature of about 700 deg. Fah.; but on the Great Western Railway it is still the practice to use only a moderate degree of superheat.

Exhaust steam injectors are now commonly employed on express locomotives, but feed-water heaters are not extensively used.

WHEEL ARRANGEMENTS.

From what has been said it is not difficult to understand why the 4–6–0 has come to be the usual wheel arrangement in British practice. The weight of modern express trains is such that six-coupled wheels are essential for reliability in all weathers, and as a four-wheeled leading bogie is almost equally a necessity for high-speed work, the 4–6–0 is naturally indicated. The "Pacific" wheel arrangement gives no advantage in the way of greater adhesion weight, and the fact that it permits of a wide fire-box is not so important as it once was. It is obvious that the additional trailing axle means a longer and more expensive locomotive, and it is not surprising, therefore, to find three of the four groups building large high-pressure 4–6–0's for their heaviest passenger work. At the same time it is likely that further developments will eventually overstep the possibilities of this wheel arrangement.

The advent of higher pressures has led to heavier boilers, even though the main dimensions have not been greatly increased, and this is causing the size of modern express locomotives to be limited by axle loading rather than by boiler dimensions. For example, the largest British 4–6–0's, the G.W.R. "Kings," have a maximum boiler diameter of 6ft. This might be increased to nearly 7ft. without occasioning insuperable difficulties on the score of clearance, but probably the greater weight would be prohibitive on ten wheels, as each of the coupled axles already carries 22¼ tons, whereas prior to 1926 no higher axle loading than 20 tons was to be found on any British locomotive, save only the R1 4–4–0 class of ten engines built by the North-Eastern Railway. These originally had an adhesion weight of 42 tons, but later modifications slightly reduced that figure.

It is conceivable that the weight difficulty may in future cause the introduction of the "Pacific" type as an extended 4–6–0, still with a narrow fire-box, rather than in its usual form as a six-coupled "Atlantic." This has already happened in France, as the largest type of "Pacific" on the Nord system is little longer or heavier than a Great Western "King," and in general construction bears more resemblance to a 4–6–0 than to a "Pacific" of conventional design.

SECONDARY SERVICES.

These remarks have applied more particularly to the development of the express passenger locomotive for the heaviest duties. The lighter passenger services are, naturally, often operated by engines displaced from first-class work by the later designs, but new construction for secondary traffic tends to show the same characteristics as the largest locomotives.

Thus the "Shire" class 4–4–0's and the "Sandringham" 4–6–0's of the L.N.E.R., together with the "School" 4–4–0's of the Southern, are high-pressure three-cylinder engines, fitted with Walschaerts valve gear, except for certain members of the first-mentioned group, which have Lentz valves. The L.M.S. Company possesses a fleet of three-cylinder compound 4–4–0's, which are admirably adapted to trains of moderate weight; these are, of course, virtually short cut-off locomotives of very high efficiency, although their design is not a new one.

The tendency towards high pressures and the use of Walschaerts valve gear is also very strong among goods and tank engines. For example, the latest 2–6–2 tank engines of the L.M.S. and L.N.E. railways, working at early cut-off, are handling suburban traffic in a remarkably efficient manner. So far as the G.W.R. is concerned, it may be said that the entire stock of locomotives built during the last thirty years is in the high-pressure short cut-off category.

FUTURE DEVELOPMENT.

The necessity for increasing the size of locomotives during the last thirty years or so has arisen from the growing weight of the trains, rather than from higher speeds. The greater weight has come partly from the increase in the number of passengers, and partly from the more lavish accommodation provided in modern trains. So far has the latter effect progressed that some of the latest first-class vehicles weigh approximately 1 ton per passenger. In these circumstances it is not surprising to find that there has been but a small general improvement in travelling times for many years past. In view of competition from other forms of transport, it may reasonably be suggested that the railways' attention should be directed towards higher speeds in conjunction with reduced tare loads.

The average start-to-stop speed of main line express trains at the present time is rather less than 60 m.p.h. Would it be practicable to raise this to, say, 75 m.p.h. without resorting to such expensive measures as wholesale electrification? With a light load a modern locomotive could just achieve an average of 75 m.p.h. over an easily graded road, but it would have no margin in hand, and timekeeping would be unreliable. The "Cheltenham Flyer" of the G.W.R. frequently betters its scheduled time of 67 minutes for the 77¼-mile journey from Swindon to Paddington, and has made the trip in as little as 58¼ minutes, giving an average of 79 m.p.h., but the tare load rarely exceeds 230 tons and the road is exceptionally favourable, being level or slightly downhill for most of the way. In the reverse direction such times have never been approached by ordinary trains. On the Canadian Pacific Railway there is a conditional timing which involves an average speed of 68·9 m.p.h. for a distance of 124 miles, over a road undulating with gradients of about 1 in 250. Here again the loads are light in proportion to the size of the locomotives employed.

If an average speed of 75 m.p.h. is to be an economic proposition it seems certain that rolling stock construction must be modified. In the first place it would not seem difficult to lighten the coaches in relation to the seating accommodation if special attention were directed to that end. Let it be assumed that a 10 per cent. reduction is possible. Secondly, the air resistance, which assumes great importance at high speeds, might be considerably lessened. If the floor level of the coach were brought as close as possible to the rail level the extreme height might be reduced from 13ft. to about 9ft. 6in., as is done in the tube trains. If the wheels and bogie frames were enclosed, the gaps between the coaches eliminated by fitting telescopic shells flush with the roofs and walls, and the surfaces everywhere made as smooth as practicable, it is likely that the air resistance would fall in proportion to the height of the vehicle. This would mean that the windage of the streamlined stock would be 25 per cent. less than that of orthodox design and of equal passenger capacity. Recent experiments in America tend to confirm that such a reduction in air resistance is practicable.

It would also be important to streamline the locomotive because of its position at the head of the train, and this suggests that the boiler should be set low down in the frame. On the other hand, it would seem appropriate to use a considerably larger driving wheel diameter than is common at present in view of the contemplated speed increase of 25 per cent. These conflicting considerations, coupled with the necessity for a boiler of large diameter to give the required power output, suggest the employment of the Garratt design. The simplest wheel arrangement suitable for high-speed running and at the same time giving adequate adhesion would then be 4–4–2+2–4–4.

In order to estimate the dimensions of such a locomotive, let it be assumed that the train to be hauled must be equivalent in passenger accommodation to a 400-ton train of average present-day main line stock, and that the engine must be capable of maintaining a speed of 75 m.p.h. up a gradient of 1 in 200. The gain in time on level and downhill would then have to offset the losses during the periods of acceleration and retardation, and to provide the necessary margin for incidental delays.

Starting from the basis that a G.W.R. "King" can maintain 75 m.p.h. continuously on the level with a 400-ton train—and every-day performance shows that this can be done without difficulty—rough calculation indicates that the proposed locomotive would have to be of approximately 50 per cent. greater power than the "King." The leading dimensions would thus be:

Heating surface	3,800 square feet
Boiler diameter	7ft. 6in.
Grate area	52 square feet
Working pressure	250 lb. per square inch
Driving wheel diameter, say	7ft. 6in.
Cylinders (six)	18in. dia. × 26in. stroke
Tractive effort, 85 per cent. working pressure	59,700 lb.
Weight with coal and water supplies	165 tons

The coal consumption, again estimating from the work of the "Kings," would probably not exceed 55 lb. per mile, or about the same as recorded in 1909 on the ordinary main line services of the late London and North-Western Railway.

The rate of firing at 75 m.p.h. might overtax the powers of one fireman, though his work would be somewhat lightened by the use of the widest possible grate, inclined throughout its length, and the provision of two fire holes.

Such a locomotive would be more expensive to construct and to maintain than any at present existing in Britain—though it might be no heavier on the permanent way than some classes now running—but, in conjunction with streamlined rolling stock it could effect revolutionary reductions in travelling times, thereby emphasising the railway's advantage over the road, and for any but the longest journeys leaving but little to be gained by aerial transport.

INSTITUTION OF NAVAL ARCHITECTS.—The Council of the Institution of Naval Architects has awarded the Premium for the year 1931 to Mr. L. C. Burrill, B.Sc., Durham University (Armstrong College), for his paper "Seaworthiness of Collier Types." The Premium will be presented at the opening meeting of the annual general meetings, which will be held on March 16th next at the Royal Society of Arts, John-street, Adelphi, London, W.C. 2.

The Justification of Organised Engineering Inspection.

By W. P. DIGBY.

No. II. (*conclusion*).*

The answer to the question as to whether inspection is desirable in all cases is an affirmative one. No firm is perfect. Preventable accidents—that is to say, accidents which would have been obviated by more thorough testing and inspection are well known to have occurred in the past, and must in the very nature of things, recur. The cost, direct and indirect, of a single serious failure may outweigh many times the cost of years of inspection. It is not always possible to take exhaustive tests. It is always possible for a purchaser, hypnotised by the international reputation of the manufacturer to elect to forego even such tests as are within the range of the works capabilities, in order to save the cost of such tests. Cases are not unknown in which the omission of such tests at the works has been followed by the failure of the machine to reach the performance guarantees with a resultant aggregate cost to the purchaser which was over twenty times the amount initially saved by omitting the tests.

Moreover, managers, designers and foremen come and go. A new *régime* may mean a slackening of control. In the competition for orders prices are sometimes so cut that materials or workmanship or both may suffer.

It is axiomatic that the greater the margin between an accepted tender and the average of all the tenders to a common specification, the greater the need for exhaustive inspection of the material supplied under the accepted tender. A lesser but still important axiom is that the more remote the destination from the place of manufacture, the greater the need for inspection.

Further, it is legitimate to urge as a third axiom that the greater the indirect monetary cost of any serious breakdown at the destination, the greater the need that all contributary human skill—that of the consulting engineer, that of the works, and that of the inspector—should have been mobilised in an effort to ensure that every possible precaution has been taken to secure the installation of the best possible equipment at the earliest reasonable date. Direct costs of replacement are usually of small moment compared with indirect costs. To mention only a few examples of the indirect cost:—A power station supplying a dock and grain elevators breaks down for any cause at the height of the season, and is unable to supply power. There is not only the loss of revenue at the power station, but the risk at worst of claims for damages from the owners of the grain elevator, and at the best the acquisition of an intangible hidden ill-will debit on the balance sheet which will take years to work off. In a bad failure in a power station with such a load there may be a diversion of grain to another port, with all that that implies in congestion at that port and demurrage on vessels sent there to load. All this enhances the intangible hidden ill-will debit.

Or, again, still dealing with known rather than hypothetical cases, failures of the over-speed governors of steam and water turbines have been followed by revolving masses going to pieces under centrifugal stress, wrecking the power-house in which they have been installed. It is no far-drawn piece of imagination to ask what will be the cost to a mining company working any wet mine at deep levels if the pumps fail, and all mining has to stop until the workings are unwatered? Obviously, many times the capital cost of the plant that has broken down.

Yet again, the collapse of a bridge apart from the loss of life or loss of capital, means for a railway company serious curtailment of earning power.

It is therefore reasonable to suggest that if the cost be spread over the normal life of the plant and a conservative estimate of the indirect cost of a serious breakdown be taken, the cost of inspection becomes an insignificant annual charge.

It must also be remembered that on some classes of work the tests carried out by an inspector before despatch from the works may serve to determine such questions as steam or fuel oil consumption, in which a difference of 2½ per cent. above a guaranteed consumption may in fifteen years be the equivalent of 20 per cent. of the f.o.b. cost of the machine tested.

Ultimately inspection as a means to an end must be judged by its fruit. Admittedly it is not easy to judge an inspector by his reports. A man whose work is good may yet present a report poor in composition with its results badly set out. On the other hand, a plausibly phrased report may cover indifferent attention to detail.

The time spent at the works is not always a criterion of the value of the work done, although the average time expended has always to be taken into account in assessing the probable cost.

The remuneration of the inspector is, except where daily rates are agreed, a matter of bargaining depending upon the class of work, the degree of responsibility and the magnitude of the interests at stake.

While the remuneration is almost always considered by the client as expressible as a percentage of the

* No. I. appeared January 29th.

f.o.b. value of the material dealt with, it is difficult to lay down exact percentages for wide application. For the same class of machinery at different works it will only take a few years of experience to learn that the time likely to be taken in inspecting work manufactured either by A or B will vary more greatly than the difference in the sum involved in their respective tenders. In some cases for the inspector to feel equal satisfaction with the material or equipment he may finally recommend for acceptance the time spent may even vary inversely with the capital cost. In short, a cut price may be a danger signal. Of course, this is not invariably the case, wages rates, the incidence of taxation, and the relations between the works load factor and the works overhead charges, are contributory factors. As the keynote of modern capital expenditure is so often a question of the lowest immediate capital outlay the works are never encouraged to put in any material markedly superior to that specified in the contract; the temptation to the works to buy cheap is therefore quite as forceful as the same temptation to the purchaser.

Whenever the question of a lump-sum price for his services arises, the inspector will desire to see the specification and to know the name of the works. Having seen it, he will estimate closely the time which it will be necessary to spend in the works, and the time spent in travelling. His knowledge of past contracts at the same works will determine the contingency allowances. Where organisation is good and equipment above the average the standard time—arrived at from a sort of actuarial subconsciousness—will be below the average and the contingency percentage also low. Of course, the converse is true. Mistakes in the computation of the cost do occur; from 60 to 90 per cent. of such under-estimates are attributable to defaults by sub-contractors. The time spent in travelling may be serious. Thus with alternator tests of ten to fifteen hours' total duration in the works, at a distance from his base of operations, the inspector's travelling may be anything from one-half to five times that spent in the works. Of two successive Continental journeys, the writer can recall in the first an aggregate travelling time of seventy-two hours with six successive days of nine hours each at the works. The next journey, to test important steel castings, involved ninety-six hours' total travelling time and just under five hours in the works. Both visits were essential. The inspector working on a lump sum basis is not paid to take risks, and dare not cut visits to increase his profit margin. The inspector's difficulty with his clients often centres round this question of risk and cost. The client will sometimes wish to cut inspection; he will say that "M. or N. are good firms; your fees are too high. I will take their guarantee." The inspector does not wish to be thought to make work. In the two successive tours just mentioned the longer journey resulted in the work being found entirely satisfactory. In the first one adjustments had to be made increasing the duration of the stay by one and a-half days. Both firms were of the highest standing in their respective spheres. In either case guarantees might have been accepted.

About once a year it is safe for the inspector to recommend his clients to accept guarantees on important matters from what he regards as a good firm whom he knows. It is safe to do this twice running with a very good firm. To do it three times is to carry the pitcher too often to the well.

We commenced these notes by saying that the real cause and justification of inspection is that of securing the maximum efficiency in the expenditure of capital. Very little more needs to be said in regard to the technical questions of securing compliance with specifications in the shape of materials, workmanship, dimensional correctness and operating efficiency. The financial side has yet to be treated, and the perhaps intangible good results balanced against the by no means intangible financial losses due to late delivery. On the technical side the inspector's remuneration is chargeable to capital account; it is an insurance cost just as much as the marine insurance premiums covering ocean transit. On the financial side efficient inspection may very often reduce capital outlay.

The tangible financial losses due to delays at all stages admit of definition, but it is not a frequent occurrence for them to be worked out and the results circulated to a board of directors. This loss may be very great indeed in some cases where, if the whole of the plant is not at its destination by some definite date, such specific local conditions as impassable roads and outdoor work prevented by monsoon rains, a frozen harbour, or a river running so low in the dry season that navigation by shallow-draught boats is not possible, will each retard completion by four to six months. Even where there is no crucial completion date dictated by local conditions, the tangible financial loss may be serious.

Let us consider the elementary arithmetic of two hypothetical cases. The first is that of a power station, steam or oil driven, abroad. The capital expenditure may be grouped under two main headings, first, that of expenditure on plant paid for f.o.b. with London office charges, and expenditure on inspection; secondly, expenditure at destination, including purchase of site, preliminary surveys, excavations of foundations, erection of buildings, ocean freight, local transport, supervision, and local office charges. Let us assume that the expenditure in this country amounts to £100,000, and that the expenditure at the site amounts to £80,000. For ease in calculation, we will further assume that the expenditure at site is equally spaced over twelve months, and that the expenditure on plant commences at the end of six months and is equally spaced in five equal instalments, payable at the end of the sixth, seventh, eighth, ninth, and tenth months. We will assume inspection costs at 2 per cent. and interest on capital expended at 6 per cent. per annum.

Then with a strict adherence to the programme, the interest on the expenditure will amount to £5175, as set out in the attached Table I.:—

TABLE I.

Month.	Plant f.o.b.	Expenditure at site.	Inspection fees (2% on f.o.b. value).	Total expenditure to date without interest.	Interest on expenditure at 6% p.a.
	£	£	£	£	£
1	—	6,666	200	6,866	34·33
2	—	6,666	200	13,733	68·66
3	—	6,666	200	20,600	103·00
4	—	6,666	200	27,466	137·33
5	—	6,666	200	34,333	171·67
6	20,000	6,666	200	61,200	306·00
7	20,000	6,666	200	88,066	440·33
8	20,000	6,666	200	114,933	574·66
9	20,000	6,666	200	141,800	709·00
10	20,000	6,666	200	168,666	843·33
11	—	6,666	—	175,333	876·67
12	—	6,666	—	181,998	909·99
	100,000	80,000	2000	182,000	5175·00

Almost invariable experience shows that strict adherence is impossible, that some contractor or sub-contractor is bound to be late. In the case in question, we will assume that all goes according to the programme, so far as the site is concerned, but that the delivery programme is dislocated to the extent that, for one case or another, deliveries commence at the end of the eighth month and finally are spaced as follows :—

7th month	£
8th "	15,000
9th "	20,000
10th "	25,000
11th "	25,000
12th "	10,000
13th "	5,000

To a certain extent expenditure on site will be enhanced as well as dislocated—we will ignore the increase in labour and supervision charges, and assume that the total site expenditure is not exceeded, but is spaced as follows :—

First eight months uniformly at the rate of £6666 per month.

Next seven months uniformly at the rate of £5800 per month.

We will also assume that inspection fees have been cut to £780. Under these circumstances, the interest on the expenditure will amount to £6584.

The details are set out in Table II.:—

TABLE II.

Month.	Plant f.o.b.	Expenditure at site.	Inspection fees (0·78% on f.o.b. value).	Total expenditure to date without interest.	Interest on expenditure at 6% p.a.
	£	£	£	£	£
1	—	6,666	60	6,726	33·61
2	—	6,666	60	13,452	67·26
3	—	6,666	60	20,178	100·89
4	—	6,666	60	26,904	134·52
5	—	6,666	60	33,630	168·15
6	—	6,666	60	40,356	201·78
7	—	6,666	60	47,082	235·41
8	15,000	6,666	60	68,808	344·04
9	20,000	3,800	60	92,668	463·34
10	25,000	3,800	60	121,528	607·64
11	25,000	3,800	60	150,388	751·94
12	10,000	3,800	60	164,248	821·24
13	5,000	3,800	60	173,108	865·54
14	—	3,872	—	176,908	884·54
15	—	3,872	—	180,780	903·90
	100,000	80,000	780	1,316,764	5,583·80

That is to say, in a case where the not uncommon delay is as predicted, the loss of interest through the delayed delivery not merely covers the difference between what some may suggest as expensive inspection compared with the lower rates that are quoted, but increases the capital outlay by a further sum of £1408, before the expenditure can become revenue earning. If it had been a case in which failure to complete by a crucial date meant four to six months' interruption of commercial operation, the figures would have been more surprising.

Let us take an equally probable case, that of a hydro-electric plant. In such an instance it is correct to assume that the expenditure at the site upon the construction of a dam, flume, or tunnel, the acquisition of land, the pipe line anchorages, and supervision at site will be greater per horse-power than for a steam-driven station of equal capacity. As a moderate example we will assume a f.o.b. expenditure on plant of £150,000, and an expenditure of £600,000 at the site, of which £360,000 has been expended prior to the placing of orders for the power-house plant and £240,000 will be expended at the rates set out below Similarly, we will assume that the first shipments of the power-house machinery commence in four months after placing the order, that despatch is completed in ten months, and that transport and completion of erection will permit the power-house to start supplying load fourteen months after the plant is ordered. Inspection is again reckoned at 2 per cent. The payments on account of capital and accrued interest at 6 per cent. on the amount expended, during the fourteen months are as follows :—

TABLE III.

Month.	Power-house equipment.	Inspection fees at 2 %	Expenditure at site during month.	Total expenditure at site and on plant to end of month.	Interest on same during month at 6 % p.a.
	£	£	£	£	£ s. d.
—	—	—	—	360,000	—
1st	—	300	20,000	380,300	1,901 10 0
2nd	—	300	20,000	400,600	2,003 0 0
3rd	—	300	20,000	420,900	2,104 10 0
4th	10,000	300	20,000	451,200	2,256 0 0
5th	20,000	300	20,000	491,500	2,457 10 0
6th	25,000	300	18,000	534,800	2,674 0 0
7th	25,000	300	18,000	578,100	2,890 10 0
8th	30,000	300	18,000	626,400	3,132 0 0
9th	20,000	300	18,000	664,700	3,323 10 0
10th	20,000	300	18,000	703,000	3,515 0 0
11th	—	—	15,000	718,000	3,590 0 0
12th	—	—	15 000	733,000	3,665 0 0
13th	—	—	10,000	743,000	3,715 0 0
14th	—	—	10,000	753,000	3,765 0 0
	150,000	3000	240,000		40,992 0 0

We will now assume that for the hydro-electric station all goes according to programme so far as the site is concerned, but that the delivery programme is dislocated by default of contractors and sub-contractors, the final shipments being three months late. We will assume, too, cheaper inspection costing, say, £1300.

The payments on account of capital and accrued interest at 6 per cent. on the amount expended during the seventeen months without making any allowance for increased labour and supervision charges, will be as follows :—

TABLE IV.

Month.	Power-house equipment.	Inspection fees at "cut" rate.	Expenditure at site during month.	Total expenditure at site and on plant to end of month.	Interest on same during month at 6% p.a.
	£	£	£	£	£ s. d.
—	—	—	—	360,000	—
1st	—	100	20,000	380,100	1,900 10 0
2nd	—	100	20,000	400,200	2,001 0 0
3rd	—	100	20,000	420,300	2,101 10 0
4th	—	100	20,000	440,400	2,202 0 0
5th	5,000	100	20,000	465,500	2,327 10 0
6th	10,000	100	20,000	495,600	2,478 0 0
7th	20,000	100	15,000	530,700	2,653 10 0
8th	25,000	100	15,000	570,800	2,854 0 0
9th	20,000	100	20,000	610,900	3,054 10 0
10th	10,000	100	15,000	636,000	3,180 0 0
11th	20,000	100	15,000	671,100	3,355 10 0
12th	30,000	100	8,000	709,200	3,546 0 0
13th	10,000	100	10,000	729,300	3,646 10 0
14th	—	—	10,000	739,300	3,696 10 0
15th	—	—	6,000	745,300	3,726 10 0
16th	—	—	6,000	751,300	3,756 10 0
	150,000	1,300	240,000		46,480 0 0

The additional interest on capital expended through delays is £5488, although inspection costs have been reduced by £1700—actually the saving will be greater, as no allowance has been made for increased overhead and labour charges at the site, owing to the delay.

Expressed in other words, one month's saving in interest on capital expended would during any one of the last three months of hypothetical delay, have covered the whole of the inspection cost on the higher scale. Moreover, while 2 per cent. on the f.o.b. value of the plant may sound excessive, it is only 0·4 per cent. on the total capital expended. We can therefore add a fourth axiom to the three enumerated earlier in this review. Recapitulating those, the axioms then read :—

(1) The greater the margin between an accepted tender and the average of all the tenders to a common specification, the greater the need for inspection.

(2) The more remote the destination from the place of manufacture, the greater the need for inspection.

(3) The greater the indirect monetary cost of any serious breakdown, the greater the need to secure the best possible equipment.

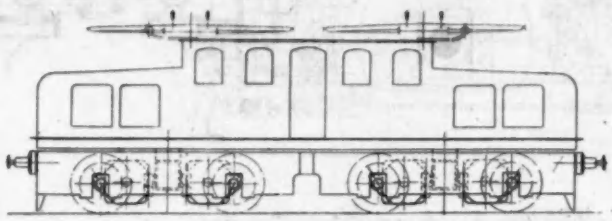
(4) The greater the ratio between the f.o.b. cost of plant and the total capital outlay, the greater the need for inspection if that inspection minimises delays in delivery.

AT the annual general meeting of Turner and Newall, Ltd., on January 28th, the chairman (Mr. Samuel Turner) informed the shareholders that Mr. Robert Turner left a portion of the residue of his estate at the disposal of Mr. H. R. Turner and himself, and that they propose, in accordance with their father's wish, to hand a sum, which would amount to approximately £40,000, to the directors of Turner and Newall, Ltd., to form the nucleus of a pension fund for the benefit of officials and employees of the company and its subsidiaries. It is the intention of the board from time to time as circumstances permit to make allocations from profits for the purpose of building up this fund.

The Mechanism of Electric Locomotives.*

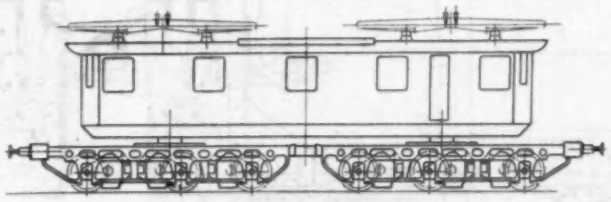
By J. D. TWINBERROW, M.I.Mech.E.

THE work of the mechanical engineer in applying electricity to traction has not figured prominently in the discussions which follow comprehensive considerations of the general problem of the electrification of railways. The object of this paper is the discussion of certain details of mechanism which appear to be desirable for the satisfactory working of some types of electric locomotives.



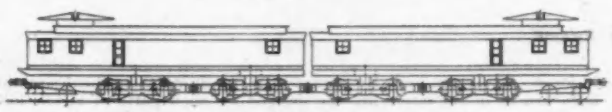
Twin geared drive; total h.p. 1,100.
Total weight, 74 tons 8 cwt.; type, $B_o . B_o$.

FIG. 1—ELECTRIC FREIGHT LOCOMOTIVE (NORTH EASTERN RAILWAY)



Type, $C_o . C_o$.

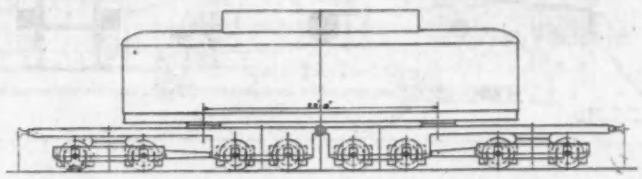
FIG. 2—ELECTRIC FREIGHT LOCOMOTIVE (PAULISTA RAILWAY)



Geared drive; type, $2 . B_o + B_o + B_o + B_o . 2$.

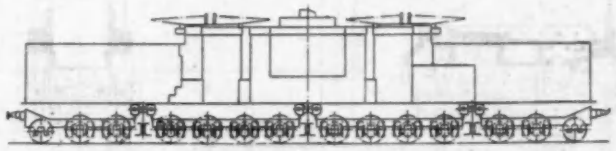
FIG. 3—ELECTRIC LOCOMOTIVE (CHICAGO, MILWAUKEE & ST. PAUL RAILWAY)

"THE ENGINEER"



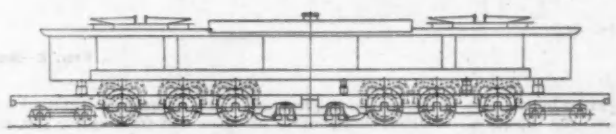
Gearless drive; type, $B_o . B_o + B_o . B_o$.

FIG. 4—ELECTRIC LOCOMOTIVE (NEW YORK CENTRAL RAILROAD)



Gearless drive; type, $1 . B_o . D_o . D_o . B_o 1$.

FIG. 5—ELECTRIC LOCOMOTIVE (CHICAGO, MILWAUKEE & ST. PAUL RAILWAY)



Quill drive; type, $2 . C_o . 1 . 1 . C_o . 2$.

FIG. 6—ELECTRIC LOCOMOTIVE (CHICAGO, MILWAUKEE & ST. PAUL RAILWAY)

SWAIN &c.

The application of the electric motor to traction work does not at first sight appear to involve the solution of any abstruse mechanical problem. It was frequently assumed that the frames and running gear of steam locomotives could be adapted to the requirements of electric working, without radical modification.

GENERAL CONSIDERATIONS.

Nose-and-Axle Suspended Motors.—The support of the motor by means of suspension bearings on the axle at one side, and by a nose resting in a suitable bracket attached to a cross member of the frame at the opposite side, permits of the application of simple spur gearing, whereby the play of the bearing springs rocks the motor on the nose support, without involving any change in the distance between the centres of the armature shaft and the driving axle.

It was found that a single pair of spur gears, having a width of face of from 5in. to 6in., when made of high-grade steel suitably heat treated, could be depended upon to transmit all the power which could be developed by a motor having the overall length limited by the space available between the wheels. Two such motors could be conveniently mounted in a four-wheel bogie truck. A body assembled with two trucks was accepted as the normal traction unit for concentrated power. This type—Fig. 1—having the wheel arrangement known as $B_o . B_o$, was generally adopted for shunting service and for working trains of moderate weight by railways using direct current.

The expected improvement in the rate of wear of track and of tires was not realised by the substitution of engines of this description for normal steam locomotives. It was found that the wear of flanges and of the rails on curves was reduced when the bogie trucks were connected by a hinged joint, capable of transmitting shearing forces, the wheel base then being conveniently described as $B_o + B_o$. The tendency of each truck to nose outwardly produces a reaction on the hinge pin and slews the wheel treads across the rails, without heavy pressure on the flanges.

Dr. F. W. Carter has shown that the moment necessary to cause the wheel base to deviate from the straight must be sufficiently great to cause the wheel treads to creep, and that actual skidding is produced only when the curvature is so sharp as to necessitate a rate of angular motion beyond the creepage limit at the treads.

In order to provide engines of greater power, three driving axles have been fitted in each bogie truck—Fig. 2—sometimes with the addition of a pony axle at each end, giving the wheel arrangement $1 . C_o + C_o . 1$. The early locomotives of the Chicago, Milwaukee and St. Paul Railroad had a group of four motor bogie trucks, each with two driving axles, the framing of the truck at each end being prolonged to take a four-wheeled guiding truck, the wheel arrangement being $2 . B_o + B_o + B_o + B_o . 2$—Fig. 3.

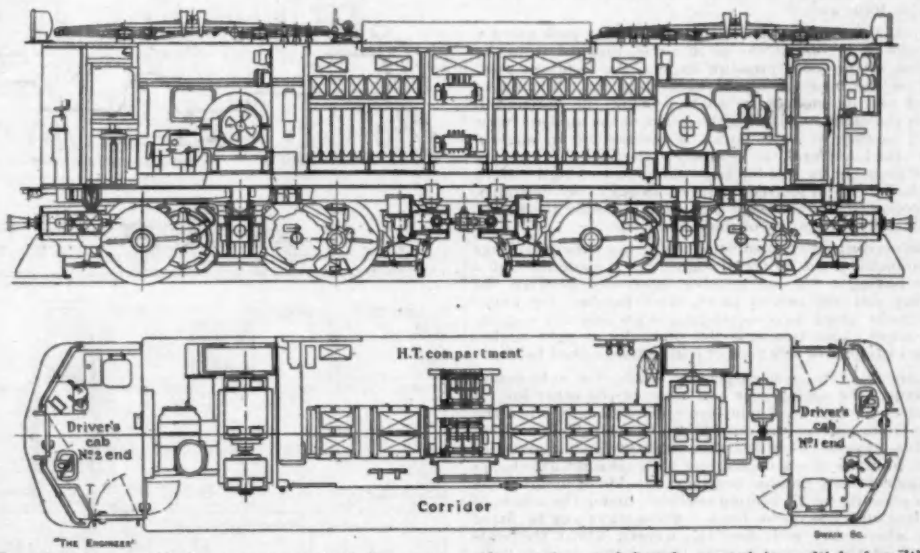
Referring to the performance at high speed of double-bogie locomotives fitted with nose-suspended motors, Mr. A. W. Gibbs reports the observation of lateral pressures amounting to 40 per cent. of the load on the axle at a speed of 68 m.p.h., whereas a modern steam locomotive on the same track at 96 m.p.h. produced impactive forces of which the maximum intensity did not exceed 15 per cent. of the axle load.

The lateral impacts are naturally intensified by the mass of the motor of, say, 4 tons weight, attached directly to the axle with its centre of gravity at a distance of about 20in. therefrom, whilst every vertical movement of the axle in the axle guards is shared by the spur wheel, involving an impact on the teeth of the wheel and of the pinion which produces an instantaneous change in the angular aspect of the rotating parts, accompanied by tangential reaction and actual slipping at the wheel tread. If there should be no slip under the instantaneous angular acceleration of the wheels, there would be an equivalent change in the linear velocity of the train, which is moving at the same speed as the circumference of the wheel. But this change would involve the assumption that each driving axle received the same impact at the same instant.

These actions, coupled with the inherent tendency to sinuous motion in the running of a pair of four-wheeled trucks, suggest that these should be used only for low-speed work, and that the nose-and-axle suspended motor should be eliminated from all future schemes for electric traction. It would seem to be practicable, without change in the overall dimensions, to mount the motor solidly in the structure, with self-contained gearing, the connection to the axle being through one of the known forms of universal joint, allowing free play to the axle without any variation in the angular velocity.

Axle-mounted Armatures.—The gearless motor, having the armature mounted directly on the axle, was adopted by the New York Central Railroad for working main line trains over the electrified lines connected with the Grand Central Terminus in New York. The first group of engines had the $1 . D_o . 1$ wheel arrangement, but the single-axle pony trucks as originally fitted were replaced by four-wheel bogie trucks, after the occurrence of a disastrous derailment. Later and more powerful engines had eight driving axles, assembled in two identical trucks, each main truck being prolonged and supported at its outer end on a pivoted motor guiding truck. This type of wheel base may be defined as $B_o . B_o + B_o . B_o$—Fig. 4.

The wheel base of the individual trucks is very short. Auxiliary control of the angular deviations of the guiding trucks was necessitated in order to suppress hunting motion at high speed. It might be thought that the small diameter of the driving wheels, coupled with the relatively great dead weight of the motor armature and lack of inherent lateral stability of the wheel base in running, would produce rapid wear of the tires and of the special work in the track. Experience, however, is understood to have demonstrated a marked superiority in this respect over the performance of locomotives fitted with nose-suspended motors. The General Electric Company's type of gearless motor—Fig. 5—was adopted for the Western extension of the Chicago, Milwaukee and St. Paul electrification.



Type, $B_o + B_o$; outside frames; nose-and-axle hung motors; three units coupled and operated in multiple from the leading cab form one main line locomotive of 3600 H.P. weighing 192 tons.

FIG. 7—GENERAL ARRANGEMENT OF LOCOMOTIVE FOR SOUTH AFRICAN RAILWAYS (3FT. 6IN. GAUGE)

Axle-mounted armatures were tried on an experimental high-speed engine for the Paris–Orleans Railway. Two motor bogie trucks, each having a four-wheeled leading truck, the wheel arrangement being $2 . C_o + C_o . 2$, lacked the necessary stability for running at a speed of 75 m.p.h. The engine was therefore rebuilt with a rigid driving wheel base and a guiding truck at each end.

Universal Driving Connection.—In order to obviate the defects inherent in the nose-and-axle support of traction motors, the Chicago, Milwaukee and St. Paul Railway, when providing additional engines for the Rocky Mountain division, adopted twin motors geared to a quill or

* The Institution of Mechanical Engineers—Jan. 29th, 1932.

hollow shaft surrounding each driving axle—Fig. 6. The connection between the quill and the driving wheels is through helical springs, arranged tangentially between the spokes and subject to extension or compression, according to the direction in which the tractive effort is exerted. Additional compression, extension, or axial bending is produced by the play of the axle in the frames, depending upon the position, vertical, horizontal, or inclined, momentarily occupied by the centre line of the individual spring. The axis of each spring is also bent by centrifugal force. No initial load can be impressed on the springs, so that the periodicity of the rotating masses which they connect is constant and independent of the variation in the deflection. By placing the springs outside of, instead of between, the spokes, the Séchéron Company, Geneva, has reduced the diameter of the circle occupied by the springs, rendering them applicable to the wheels of locomotives and of motor coaches of about 3ft. 4in. diameter. Good results have been obtained by mounting each spring under compression between follower plates in the form of cylindrical containers, so that the application of torque in either direction produces increased compression, whilst the outer ends of the containers of the springs when in a horizontal position can slide between parallel facing pieces on the spokes when the axle plays vertically in the hornblocks. The earlier type of spring drive was fitted to a number of engines on the Swiss Federal Railways.

When the two pinions of the twin motor each exert a pressure of P tons at the pitch circle, inclined from the tangent of the tooth pressure angle α, the resultant pressure on the bearings of the quill is in the direction of travel and inclined at an angle α below the horizontal. When the radial line joining the centre of the quill and spur wheel to that of each pinion is inclined at an angle θ above the horizontal, the intensity of the resultant pressure is $2\,P \sin \theta$. In view of the large diameter and high surface speed of the quill journals reduced pressures are desirable, but reductions of the angle θ involve lessening the height of the centre of gravity of the motors.

The necessity for transmitting the torque through springs is eliminated if the universal connection is made through a joint having a floating member interposed between the driving and the driven parts, with freedom for linear movement along two rectangular axes and for angular movement about two axes also mutually at right angles. Some examples of this type of joint are described below.

Framing.—The nose-suspended motor, the axle-wound armature, the spring gear and some of the other known forms of the universal joint are applicable only when the main frames are placed outside the wheels. This position is advantageous solely from the facility which it gives for using journals of small diameter with oil-tight axle-boxes having centrally pivoted bearings, capable of maintaining even pressure on all bearing surfaces, under the action of vertical and transverse loads. Cross stays can be fitted only where they will clear the wheels, whilst the wide spread of the bearing springs necessitates greater flexibility and a higher centre of gravity in order to attain riding characteristics equal to those readily obtainable with inside framing and comparatively light springs. Equal periodicities of transverse oscillation with the same moment of inertia of the superstructure require the ratio of the stiffness of the outside to that of the inside springs to be inversely as the squares of the transverse distances between the centres. Rolling through a given angle will produce the same percentage of variation of the load on the inner and the outer spring when the stiffness varies inversely with the spacing, but the variation of pressure on the adjacent wheel treads will be greater with outside springs. When the arrangement includes some axles with inside and others with outside springs, a due relation must be observed in the flexibilities in order to avoid risk of derailment.

Inside framing may be completely braced from end to end, in the form of a simple box girder. As it is not necessary to spread the frames in order to receive a cylinder block or a fire-box, sufficient space may be found for attaching the hornblocks, spring rigging, break gear, &c., to the outer faces of the frame plates, giving greater accessibility.

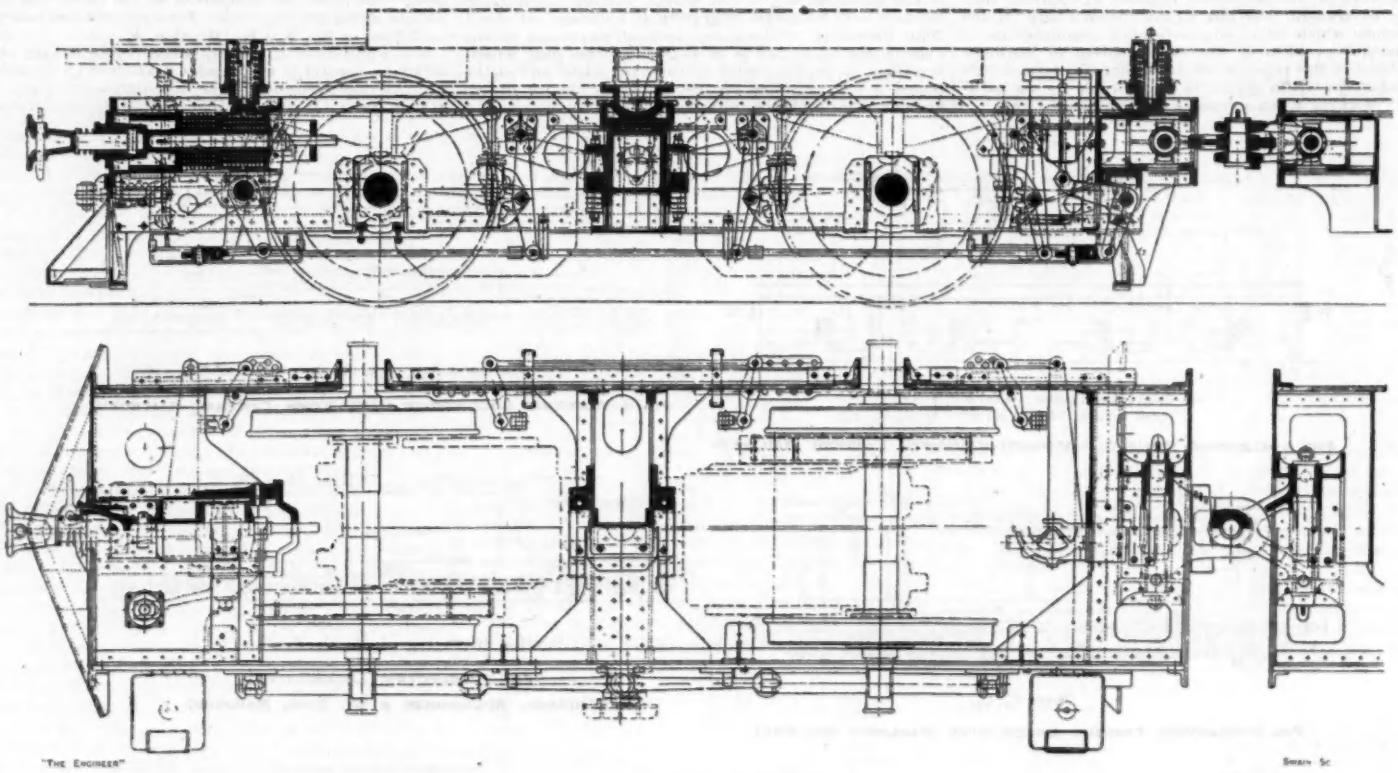
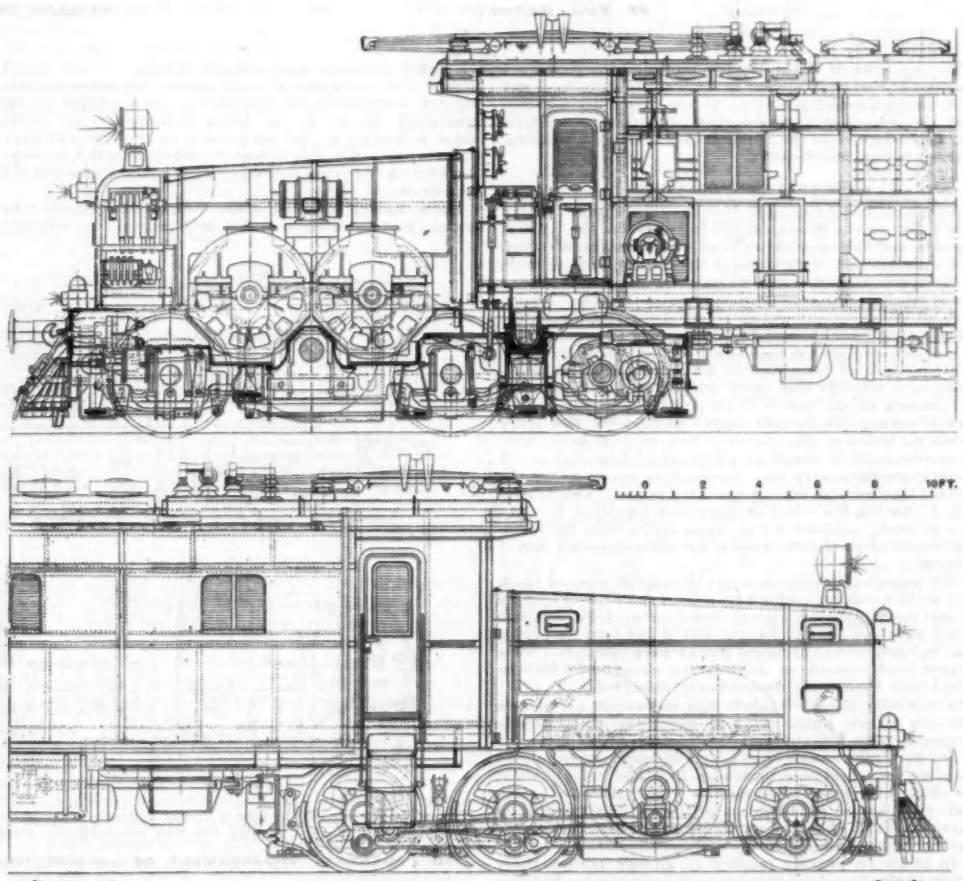


FIG. 8—BOGIE FRAME

By adopting a standard form of "Pacific" type running gear and framing for the motor bogie trucks of the later Milwaukee locomotives—Fig. 6—improved performance was expected. The total wheel base of this 2 . C_o . 1 +1 . C_o . 2 arrangement was 79ft. 10in. Each motor truck retained the standard equalisation of the bearing springs into two groups at each side. Since the truck frames are stabilised against torque and brake reaction by fore-and-aft steady bearings under the superstructure, the subdivision of the equalisation into four groups at each side becomes redundant and the engine can no longer adapt itself to vertical irregularities without disturbing the incidence of the load. The main frames had to be placed outside the wheels and no effective compensation in the structure was found for the absence of the boiler and the expansion bracing plates. The riding characteristics were modified by the great increase in the transverse spacing of the springs. The result indicated the desirability of modifying the designs for such parts of steam locomotives, in order to apply them successfully to electric traction.

Coupling-rods.—The drive through side rods provides the simplest form of connection between motors mounted in the frame and the driving axles, allowing for movement on the springs with an inappreciable amount of modification in the instantaneous angular aspect of the driving with respect to the driven rotating parts.

In the early examples of electric locomotives, the Scotch yoke was favoured as a simple means of connecting two



Type, C+C; inside frames; twin motors geared to jackshaft, driving through connecting and coupling-rods; 2600 H.P.; weight, 125 tons.

FIG. 9—GENERAL ARRANGEMENT OF FREIGHT LOCOMOTIVE. CLASS $\frac{EF}{1}$. NOS. 4500-4540 (5FT. 6IN. GAUGE)

crank shafts, directly driven by the motors, to a single crank shaft forming the middle member of the coupled axles.

By inverting the Scotch yoke, and by mounting the ends on the cranks of the driving axles, with the motor drive operating through the slide at the apex, the triangular coupling-rod is realised. The detailed design of such rods has already been discussed by the author.

Riding Characteristics.—A steady platform is required for the support of electrical control equipment, gauges, current-collecting devices, &c. This involves the provision of springs of adequate flexibility, the location and grouping being, however, of more importance than the actual consequent upon the absence of equalisation. Risk of derailment due to a flange climbing the rail is avoided by ensuring that the oscillations about vertical and transverse horizontal axes and the reaction to the tractive and braking efforts shall cause the least possible modification to the loads on individual wheel treads. Oscillation around a vertical axis, producing sinuous motion on the track, must be controlled by the avoidance of axle groupings, which have an inherent tendency to hunting movements, and by giving an asynchronous characteristic to the lateral control of the transverse play of bogie and pony axles, with effective damping in the cross slides.

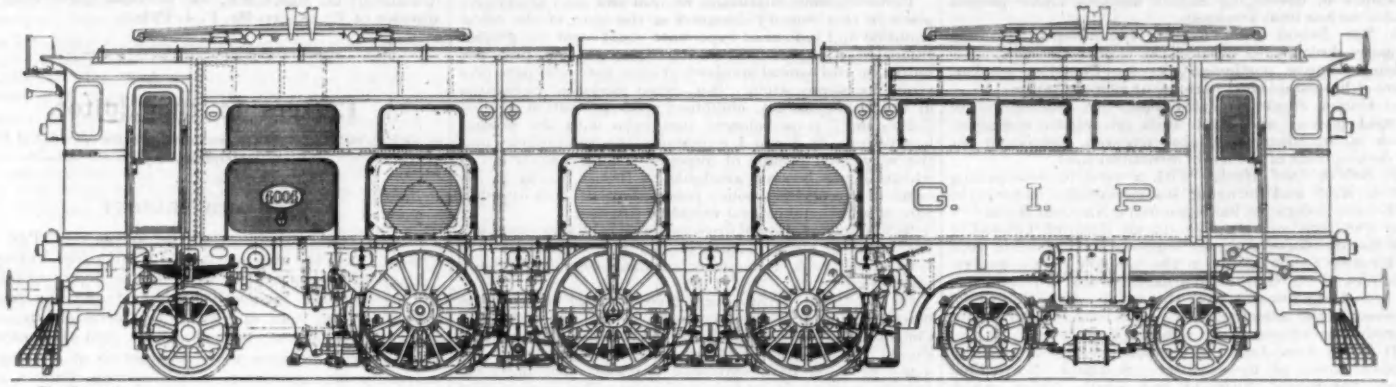
Ease of motion demands low periodicity and short deflection under load. The durability of the springs depends on the maintenance of a low range of the working deflections and stresses, by reason of the compensated action of groups, rather than by the adoption of a low stress under static load with the necessarily high range amplitude in order to obtain low values of the accelerations produced by displacement from the normal position.

When all the bearing springs at each side of the bogie truck are directly equalised, the truck frame must be stabilised by the use of a large flat pivot or preferably by means of fore-and-aft steady bearers. When the bearing springs are in two or more independent groups, the truck frame is stabilised thereon and the body should be supported through the equivalent of a hemispherical pivot. Stabilising the frame, both upon the bearing springs and through the bearers beneath the superstructure, renders the bogie ineffective to take vertical irregularities in the track without distressing the springs.

In the case of motor bogie trucks, having two or more axles, it is found preferable to equalise the springs into a single group at each side and to stabilise the truck frame by means of fore-and-aft steady bearers, with a hemispherical pivot capable of transmitting tractive and braking efforts without appreciable wear or slackness of fit. This arrangement involves the least possible change in the adhesion at the wheel treads, which is of importance when the axles are independently driven.

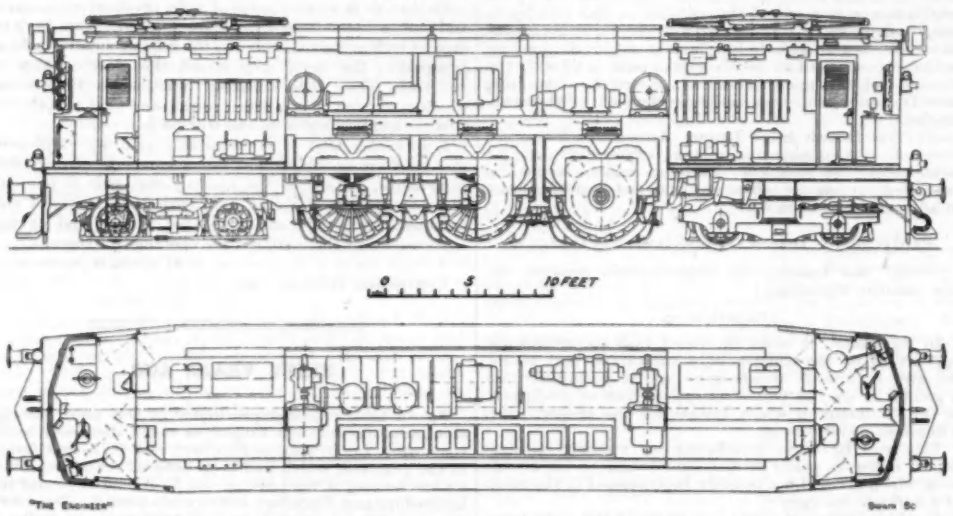
Types Described.—Figs. 7 to 12 may serve to illustrate the practical application of some of the principles, as outlined above, to electric locomotives for lines of 3ft. 6in. gauge in South Africa, and of 5ft. 6in. gauge in India.

(To be continued.)



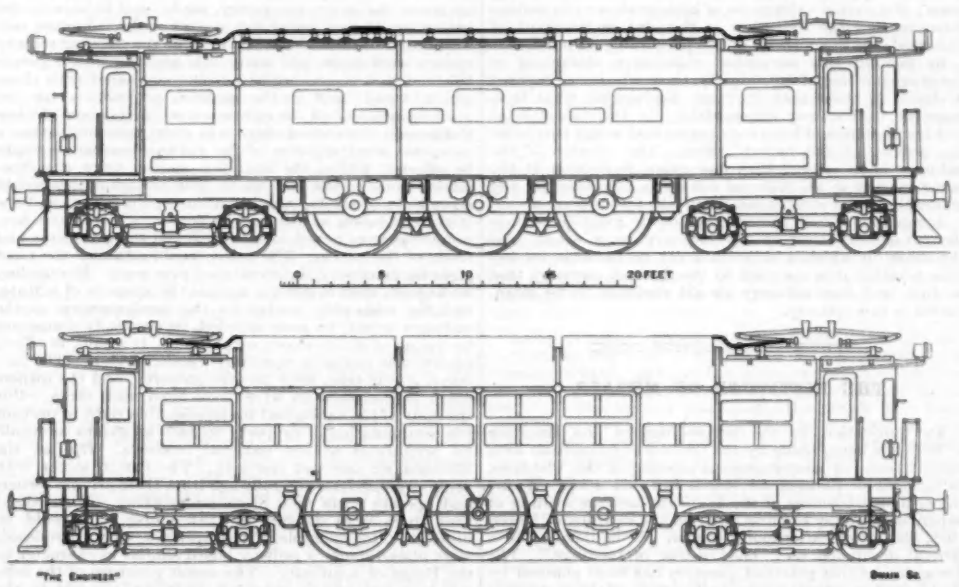
Type, 1 . A + B_o . 2 ; inside frames ; two motors paired axially operate each driving axle through double reduction gearing and a centrally placed universal gear ; 2200 H.P.; weight 101 tons.

FIG. 10—ELEVATION OF HIGH-SPEED LOCOMOTIVE. CLASS $\frac{EA}{1}$. NOS. 4003-4024 (5FT. 6IN. GAUGE)—METROPOLITAN VICKERS



Type, 2 . C_o . 2 ; outside main frames, inside bogie frames ; twin motors geared to quill surrounding each driving axle, with universal gear coupled directly to two crank pins in one wheel of each pair ; 2400 H.P.; weight, 114 tons.

FIG. 11—HIGH-SPEED LOCOMOTIVE. CLASS $\frac{EB}{1}$. NO. 4001 (5FT. 6IN. GAUGE)—GENERAL ELECTRIC



Type, 2 . C_o . 2 ; inside frames ; twin motors above each driving axle are geared to a large spur wheel mounted on a trunnion fixed in a cast steel external frame, with universal gear coupled directly to two crank pins fixed in the wheel centre ; 2400 H.P.; weight, 111 tons.

FIG. 12—HIGH-SPEED LOCOMOTIVE. CLASS $\frac{EC}{1}$. NO. 4002 (5FT. 6IN. GAUGE)—BROWN, BOVERI

The Present Position of the Iron and Steel Industry.

A COMMITTEE of Iron and Steel Manufacturers recently prepared a long memorandum on the Position of the Iron and Steel Industry, which it submitted to the President of the Board of Trade on January 12th. Extracts from the memorandum are printed below. The signatories in their own persons control 70 per cent. of the steel production of the country, but represent the whole heavy iron and steel industry. The memorandum opens with a review of the depressed condition of the industry, and then considers the causes contributing to the decline and the means of reviving the industry.

FACTORS CONTRIBUTING TO DECLINE.

(i.) *Free Import Market.*—Great Britain being a free market permits competition from low-wage countries and the dumping of surplus production below the cost of production in the country of origin ; also competition subsidised by various methods, such as special railway rates for export trade.

(ii.) *Much Heavier Taxation* and social service charges in the United Kingdom than abroad. Cost of social services 200 per cent. higher than in 1913.

(iii.) *Higher Capital Charges.*—All competing countries have rehabilitated their industry out of war compensation or national funds and have liquidated their pre-war fixed capital debts by inflation. In the United Kingdom the interest on fixed capital amounts to not less than 15s. per ton at present rate of production, whereas, if working at full capacity, fixed interest charges would be in the neighbourhood of 6s. 6d. per ton, showing the influence of volume of production on the incidence of fixed charges.

(iv.) *Wages.*—The ratio of average wages on a gold basis in the iron and steel industry of the United Kingdom and those of Continental countries is represented by the following : United Kingdom, 100 ; Germany, 59 ; France, 47 ; Luxemburg, 44 ; Belgium, 40. Continental wages have declined further since these ratios were calculated.

(v.) *Burden of Railway Charges and Sheltered Industries Generally.*—Railway rates are still of the order of 55 per cent. above pre-war and represent 20 per cent. of the realised prices for the products of the industry, whereas the selling prices of those products are only 4 per cent. above pre-war. The sheltered industry element in manufacturing costs is generally of the order of 60 to 70 per cent. higher than pre-war.

(vi.) *The Premature Return to the Gold Standard* in 1925.

As a result of these various factors, the present disparity in cost levels between this country and the Continent is so great that it is definitely impossible for any superior efficiency of British industry ever to meet it.

MEASURES TAKEN TO MEET THE SITUATION.

—A large number of measures of a corporate nature have been taken which may be briefly summarised.

(i.) *Amalgamation.*—Important groups have been amalgamated in Scotland, North-East Coast, Lancashire, Sheffield and South Wales, the five regions which successive inquiries have visualised as being suitable areas for amalgamation. Further reorganisation on these lines requires, however, additional capital and a measure of confidence in the future of the industry which, under present conditions, is entirely lacking.

(ii.) *Co-operative Action*: (*a*) *Through Trade Associations.*—These have for their general object the stabilisation of prices in the interests of both producers and consumers. Recently co-operation with consumers to a greater degree through the granting of rebates and special financial assistance in developing export markets under present conditions has been arranged.

(*b*) *The British Steel Export Association.*—A selling company designed to develop the export trade which is making progress particularly in the Canadian market, where it has established permanent representation.

(*c*) *British Steelwork Association.*—An Association of of steel makers and steel users (structural engineers) which is, in effect, a market research association for the development of the use of structural steel.

(*d*) *British Steel Mark.*—With a view to popularising British steel and bringing its advantages before the public, the Federation has registered a National Mark.

(*e*) *The Iron and Steel Industrial Research Council.*—This has developed from an organisation formed in 1925 for securing fuel economy in the industry on the general principles of the German Warmestelle and is responsible for promoting research into the whole of the industrial processes of the industry, with a view to the improvement of productive efficiency and reducing costs.

(*f*) *Heavy Steel Industry Committee.*—This consists of representatives of five districts—Scotland, North-East Coast, Lancashire, Sheffield and South Wales—which meets to consider the productive and commercial policy of the heavy steel industry in its broadest sense.

Efficiency of the Industry

The general charges of inefficiency of the industry have been made by those unconnected with it, and without technical knowledge as a superficial explanation of the depression without relating that depression to the real causes of political, financial and economic origin outside the control of the industry itself.

Generally, it may be claimed that under the conditions that have obtained in the past ten years, the efficiency of the British iron and steel industry is high and its productive plant is in such a condition that it can be readily brought up to the highest standard of efficiency when sufficient confidence is restored to warrant additional capital expenditure. It is accepted by those foreign competitors who have visited them that there are British works unsurpassed, if not unequalled, in the general efficiency of their plant and productive methods. It is not easy to demonstrate the efficiency of the industry in a non-technical memorandum, but it is at least significant that the most acute competition with which the industry is faced comes not from America and Germany, which are regarded by critics as being the most efficient, but from the low-wage countries of Belgium and Luxemburg.

Conditions Precedent to Recovery.

In this the most highly industrialised country in the world, national policy must obviously be concentrated on the restoration of prosperity to industry and the increase of employment, and this should be the main consideration in domestic and foreign policy, as the only method of restoring to this country world leadership.

(*a*) In order that the industry may operate under the most efficient conditions and so secure the lowest possible costs the maximum volume of production which the markets open to the industry permit must be obtained.

This requires at least equality of opportunity with competitors in the home market. Present competition from the Continent is based not on superior efficiency, but on their being able to sell a proportion of their output at less than the costs of production. The 3 million tons of imports which this country is now importing annually represent less than 10 per cent. of the productive capacity of the Continent. The Continental makers even under normal conditions find it profitable to dispose of this percentage in Great Britain at prices less than their home prices. At times like the present competition for orders in Britain's free market involves Continental makers in a substantial loss. For instance, the *Bergwerks Zeitung* of November 29th last states that the sale of semi-finished material, joists and railway material is taking place at from 50 to 70 marks below the cost of production. French iron and steel makers corroborated this in the past few weeks by stating that they were selling for export at 40 per cent. below their cost of production. Conditions such as these have forced the British works into a competition which has involved the dissipation of capital which can only mean in the long run the ruin of British industry. As has already been pointed out, British industry is supporting a large proportion of the capital expended to meet national needs during the war, while other competing countries have not only written off war capital, but either by war compensation or inflation have written off the whole of their pre-war fixed capital indebtedness. Competing countries have therefore highly equipped, expanded and modernised iron and steel industries without a proportionate additional capital indebtedness.

(*b*) A revision of our fiscal system which will make it possible for British industry to negotiate with their international competitors an agreement for the regulation of the iron and steel trade of the world, having for its object the raising of world prices at least to such a level as will ensure a legitimate profit above the cost of production, while, at the same time, leaving a margin for the free play of competitive efficiency.

(*c*) A reduction in railway rates so as to make them more commensurate with the wholesale price index and to ensure that they do not impose a burden on the industries disproportionate to the services rendered.

The Future of the Industry.

(i.) If existing conditions are allowed to persist, the result to the industry must prove disastrous, and involve a large proportion, if not the whole, of it in collapse, which will render rebuilding exceedingly difficult, if not impossible, and certainly delay its recovery for many years even with a protected home market.

The industry has exhausted not only its own liquid resources, but its borrowing powers in the past ten years, during which it has been exposed to the competition from industries subsidised in the manner already described. It cannot be too clearly or definitely stated that the industry is not responsible for the results of the failure to provide conditions within which it is able to secure its own recovery. The conditions which have caused its decline have been imposed upon it from without as a result of the post-war policy pursued by successive Governments.

Under existing conditions, no iron and steel productive plant in this country designed in the light of the latest scientific and industrial experience could meet the present competition experienced in this market and pay any return on the capital involved, or even earn adequate provision for depreciation. But, given moderate protection in the home market, combined with protection against "dumping," it is believed that even with the present low volume of demand represented by production, plus the very large volume of imports—a large proportion of which should become available to British works in the event of a protective policy being adopted—that expenditure of additional capital would be justified.

(ii.) Amalgamation of firms producing the same products has been the progressive policy of the industry, and a very considerable measure of amalgamation has already taken place.

(iii.) If Great Britain were given control of her home market international agreements would be facilitated. Continental countries are anxious that the British industry should participate in international arrangements, and many of them have expressed the view that until the British market is protected no effective stable international Cartel is possible. They admit that they are dumping their surplus production in competition with each other at even 40 per cent. below their own costs of production, and they would rather have a regulated market on which they could base their own immediate and future policies than the uncertainty which obtains at present. The destruction of confidence which a falling price level has engendered has caused a restriction of capital enterprise to a level below what is potentially possible.

(iv.) In the Dominions, where British industry has a preference, and where iron and steel industries have been established as a result of the inability of this country to supply their needs during the war period, negotiations have been begun with India, Canada, Australia, and an invitation extended to South Africa, with a view to the British and Dominion industries concerned co-operating with Dominion industries in the development of their own markets.

(v.) The British Steel Export Association forms the basis of a comprehensive selling organisation for the development of overseas markets, which would be expanded to ensure effective technical representation in all consuming markets.

Protection: Disadvantages and Advantages.

[Under this heading the memorandum presents the now familiar arguments.]

Conclusion.

In conclusion, it must be stated that the alternative appears to be the collapse of a substantial part of the industry to a scale at which it may be maintained for a greater or shorter period on special lines of production in the technique of which Britain for the present holds a diminishing advantage.

This will be quite insufficient for meeting national needs, either in peace or war, and would be on a scale from which it could not possibly be expanded in the event of a national emergency.

In this country the raw materials of the industry—ore, coal and limestone—are associated in much closer proximity than in any other country. These natural advantages over competing countries have been an important factor in the birth and development of the iron and steel industry of this country and provide a sound foundation on which to build the future prosperity of the industry when suitable economic conditions are created.

These relative advantages are less to-day than in the past century, due to the high cost of British railway rates; the partial exhaustion of high-grade ores in various districts, and the reduction in the cost of transport of imported ores in countries not so favourably situated.

In making this somewhat exhaustive statement of the grave position of the industry, those who have prepared it desire to state that they are discharging what they conceive to be their responsibility to the Government and the Nation, and have not exaggerated in any particular the gravity of the present crisis. The position of the industry is so critical that immediate protection of the home market is an essential condition precedent to any action that the industry can itself take for its revival.

A continuance of present conditions must jeopardise the future existence of the industry as a whole, and the issue on which a decision must be made is no less than whether it is essential to the national economy that an iron and steel industry should continue to be maintained in this country.

THE INSTITUTE OF METALS.

An innovation in the proceedings of the Institute of Metals is being made by the Council in connection with the forthcoming annual general meeting of the Institute, to be held in London on March 9th and 10th. Whilst the ordinary business of the Institute and the reading of papers will occupy the first day and the morning of March 10th, the second afternoon's session will be devoted to a general discussion on "The Testing of Castings." The discussion of this practical question has been planned by the Council in order to interest all sections of the Institute's membership—those engaged in practical foundry work, engineering users of castings, and testing and investigation experts. The discussion will be opened with a short paper by Dr. W. Rosenhain, F.R.S. Visitors are invited to take part in the discussion. Cards of invitation admitting to the meeting may be obtained on application to the Secretary, Mr. G. Shaw Scott, 36, Victoria-street, Westminster, S.W. 1, who will also supply information regarding an election of members that is due to take place on February 18th. Persons then elected will have the privilege of membership, not for the usual twelve months, but for the extended period ending June 30th, 1933, and will be in a position to take part in the proceedings at the March meeting, at which, in addition to the above-mentioned general discussion, fourteen papers will be presented. The annual dinner will be held at the Trocadero Restaurant on March 9th, the principal guest being the Minister of Transport, Mr. P. J. Pybus.

Letters to the Editor.

(We do not hold ourselves responsible for the opinions of our correspondents.)

PAST AND PRESENT.

Sir,—I read with interest your article on "Past and Present," also the obituary notice of Sir Alfred Yarrow.

I should like to ask, to what is this higher education and catering for mediocrity leading? At the present time the young man who leaves the secondary or public school at the age of, say, seventeen, and then receives a further two or three years' instruction at a college or university of engineering, in my opinion, finds a great deal of difficulty in getting the initial start in the engineering world of to-day.

At the present time we seem to be getting away from the old apprenticeship methods of Yarrow's time. Surely the man to succeed in the small shop as owner-manager is the man with the practical experience from the shops. In the small shop one gets anything from overhauling a steam tractor to press tool making, and the thing is to get things done and done quickly. The great thing in running a small concern is also never to turn work away.

To do this it needs a man of wide practical experience, and not a little theory carefully applied. But for the man of college and university, the man of small practical experience, the small shop is not the place. There is one thing more than training, practical or theoretical, which is needed in the small works, and that is self-confidence, and without it no one will get far.

I note also that it is frequently said by employers that they are unable to find young men with courage and personality. I am of the opinion that this is not so; there are plenty of young men with both practical and technical knowledge and with the courage and energy to succeed, but there are not the openings for them.

G. Geo. Woodcock.

Tottenham, February 1st.

SIXTY YEARS AGO.

As we have recorded previously in this note, railway amalgamation was the subject of much discussion sixty years ago. In our issue of February 9th, 1872, we referred to the proposal, which had been debated for a long time, for the uniting of the London and North-Western and the Lancashire and Yorkshire railway companies. These two companies between them owned 1927 miles of railway, and had a joint capital of £88,000,000. The question of their union was, we contended, one of great public interest, for we anticipated that if these two companies amalgamated they would set an example which might be followed to its logical conclusion, the union of all the British railways, representing an aggregate capital of £530,000,000, in one vast undertaking. We did not regard such a possibility with an easy mind. Parliament, we felt certain, would find it difficult to withstand the pressure which such a body would be able to exert, and as a consequence the entire prosperity, trade, and finance of the nation would pass under the control of the federated railway board of directors. The evils of the existing railway system were great, but many able and thoughtful people believed that they were as nothing compared with those which would arise if the gigantic proposition for the amalgamation of all the railways were carried out. Unless Parliament intervened there was every possibility that a universal amalgamation of the railway companies might be effected within the next few years. Once the companies came to the conclusion that amalgamation would serve their interests, amalgamation would follow, and the step once taken would be irrevocable, whether the consequences were beneficial or hurtful to the commerce and trade of the nation. The union would establish the most gigantic monopoly the world had ever seen. Monopolies, we argued, were in general against the interests of a State, and the monopoly created by the amalgamation of the railways would, we were satisfied, be especially dangerous by virtue of its enormous magnitude. It would, in effect, enslave the public to a railway Feudal System. The railways, it was true, were private property, and the owners could legitimately do what they liked with them. But the body of the nation had the indefeasible right to prevent the accumulation of property to such an extent as would be prejudicial to the national interests. Out of the dilemma we saw but one way. The nation might with propriety purchase the railways from their private owners and operate them as a State undertaking. We realised that there were dangers in that course. It would be disastrous, for example, if the railways, when purchased, were placed under a railway board similar in character to the Board of Admiralty. The recent purchase of the telegraphs by the State provided, however, a guide to the manner in which the position might be handled. We suggested that the railways might be transferred to the State, but nothing would reconcile us to transferring the whole control over them to the Government. Our meaning was that after purchase the railways, with certain modifications, might be worked as they were then being worked, and without displacing the engineers and traffic managers then in office. No "places" would be put at the disposal of any Minister. Fifty years were to pass before amalgamation into four groups was virtually imposed upon the railways by Parliament.

Railway and Road Matters.

DURING 1931 the L.M.S. Railway Company built 132 new locomotives. Forty-seven were built at Derby, seventy at Crewe, and fifteen at Horwich.

THE number of passenger journeys made by trackless trolley vehicles in Great Britain during 1931 was 153,004,554, compared with 127,461,837 in 1929–30, an increase of 20·04 per cent.

MANY of the large works now, and till recently, in hand on the Great Western are the result of the Development (Loans, Guarantees and Grants) Act, 1929. Forty schemes received help from that source, of which twenty have been completed and are in use, and nine are due to be finished this year.

IT is recorded in the *Railway Gazette* of January 22nd that on a recent evening a local train arrived at King's Cross and its passengers were detrained, the driving engine detached and a fresh one coupled on in front, the outgoing passengers loaded up and the train away again in seventy seconds. The following evening another train was similarly disposed of in seventy-three seconds.

THE railway companies convey some 240 million gallons of milk each year to London and other large centres of population. Much of it is carried in special fast milk trains. The glass-lined metal milk tanks, now being widely used, hold between 2000 and 3000 gallons, and have greatly reduced the number of churns, and thus save time and labour in handling. As showing how little the cost of carriage affects the price of milk, it may be said that five pints are conveyed from Salisbury to London for one penny.

THERE has been a steady development on the Great Western Railway in the establishment of express freight trains, many of which maintain speeds of up to 45 m.p.h. for considerable distances. During the four weeks ended October 24th last, 1247 vacuum-fitted trains were run, and the average train miles per engine hour secured by these trains was approximately 20. In addition, 1390 fast and semi-fast non-vacuum trains were run, of which the above average was 13. These averages include marshalling and shunting time.

IT is announced by the Society of Motor Manufacturers and Traders that a "constructive reply" by all road traffic interests to the recently issued statement of the railway companies will be sent to the Ministry of Transport in due course. The estimate of the railways that only some £20 million are provided from motor taxation towards annual road cost of £60 million is challenged. The road experts state that for the coming financial year the produce of motor vehicle taxation and petrol duty will exceed the whole cost of the construction and maintenance of the roads of the country.

THE report of the general manager of the South African Railways for the year ended March 31st last opens with comments on the present world-wide economic depression. These, however, close on a high note :—"However, although trade recovery may be longer delayed than was at one time expected, there is no reason to doubt either the rapid recuperative powers of South Africa when the tide turns, or the ultimate future prospects of the country's agricultural, industrial, and commercial pursuits, upon the steady development of which the prosperity of the railways and harbours is so vitally dependent." The railway revenue for the year amounted to £24,321,854, and the expenditure to £19,308,444, as compared with £26,130,549 and £20,878,539 respectively for 1929–30, a surplus of £5,013,410 as against a surplus of £5,252,010. The ratio of expenditure to receipts was brought down from 79·90 to 79·39. There was a reduction of 10·57 per cent. in the maintenance of the permanent way, of 8·24 per cent. in the maintenance of rolling stock, of 10·39 per cent. in running expenses, and of 7·22 per cent. in traffic expenses.

AN extremely satisfactory feature about the Welwyn derailment of September 29th is referred to by Colonel Trench in his report. The derailment occurred, it will be remembered, because the points were moved under the train. The trailing bogie of the third coach, following the engine and first three carriages, had cleared the points before they began to move. The leading bogie of the fourth coach encountered them as the switches were in the midway position, and its wheels were derailed, but by the time the trailing bogie of the fourth coach arrived the points were over, and not only that bogie but the remaining six coaches went along the up goods line. The space between the up passenger and the up goods line was 11ft. 3in., and the fourth coach ran askew like that for a distance of 270 yards. As Colonel Trench remarked, it is difficult to imagine a derailment such as the one under notice which could have resulted in less damage, and he thinks that the presence of the Buckeye couplings with which all the coaches were fitted must be recognised as a very important factor in contributing to that fortunate result.

THE way in which the railway supply business, in common with other industries, suffered last year from the world-wide depression in trade, is reflected in the recently issued Board of Trade export tables for December, which also give the figures for the whole year. These show the value of the railway material sent overseas during the year 1931 to have been as follows; the corresponding figures for 1930 and 1929 are added in parentheses :—Locomotives, £1,496,896 (£3,570,743, £3,275,153); rails, £913,347 (£2,084,558, £2,755,873); carriages, £1,168,578 £1,844,799, £2,418,489); wagons, £945,027 (£3,176,767, £2,397,510); wheels and axles, £173,880 (£376,912, £419,404); tires and axles, £319,640 (£668,314, £630,829); chairs and metal sleepers, £431,247 (£609,946, £520,274); miscellaneous permanent way, £439,499 (£863,709, £1,052,474); total permanent way, £2,322,811 (£4,707,411, £5,546,021). The weight of the rails exported was 109,245 tons (239,230 tons, 326,075 tons), and of the chairs and metal sleepers, 55,046 tons (63,975 tons, 51,773 tons). During the month of December last locomotive material to the value of £3980 was shipped to India and £1215 to South America. The rail exports for the same month were of the value of £101,697, and included :—South Africa, £60,928; Ceylon, £14,277; Portuguese East Africa, £7666; and British West Africa, £3046.

Notes and Memoranda.

ACCORDING to Mr. J. Petch, of the Republic Steel Corporation of America, one-third of the steel production of the world, in ten years' time, will be of the stainless variety.

IN a letter to the editor of *Nature*, Messrs. Southgate, Pentelow and Bassingdale, of the Marine Biological Association, suggest that cyanide is the factor mainly responsible for the death of fish in the Tees estuary. A method whereby cyanide-containing effluents from coke ovens are rendered innocuous by the addition of spent pickle liquors is, however, being worked out, and it is hoped that treatment on a works scale will soon be possible.

ACCORDING to Professor F. C. Thompson, the properties of the lead-base alloys for bearings would appear to be inferior, thermally, to those based upon tin. The thermal capacity of a given tin-base bearing is very much greater than that of a lead-base alloy, so that for a given amount of heat generated, the rise of temperature of the bearing would be distinctly less in the case of the tin-base than in the lead-base alloy. This has an important secondary effect. The stress at which the metal begins to flow rapidly falls as the temperature rises, with the result not only that the lead-base alloy is initially weaker, but that it becomes even more so under severe conditions of service when compared with an alloy consisting essentially of tin. In addition, the thermal conductivity of tin is about twice that of lead.

A NEW type of omnibus, produced by the combined experience of companies associated with the British Electrical Federation, was recently tested at Loughborough. An outstanding feature of the new vehicle is its silence. Special insulating material has been used between the floor and the floor covering, coconut matting having been placed on top of this to deaden any resonance. The windows and doors cannot rattle. The front bulkhead is equipped with sound-proofing material to cut out sound waves. On the long test made through Charnwood Forest passengers in the vehicle heard no sound but their own voices and the occasional klaxon of a passing car. Other features of the new omnibus are indirect lighting, which floods the interior with powerful light; armoured plywood panelling for safety in case of collision; thermostatic heating; covered luggage racks; specially comfortable seating. The first of these vehicles in public service is to run immediately in the Thames Valley between London and Reading.

LIKE Manchester, Glasgow is experimenting with the new system of regenerative control in the operation of electrical tramways. The development has been sufficiently tested in Glasgow to satisfy the engineers of the department that there is much merit in the system. At the quarterly conference of the Scottish Tramways and Transport Association it was stated that a saving of almost 30 per cent. in the use of the electrical power is to be derived from the control. This places the claims made for the new system as an economical development much higher than those which were stated by the Paris tramways administration when Glasgow officials inspected the working of the system there about a year ago. Those in charge of the Glasgow Transport Department are fully persuaded that in cases where the supply of electrical power to tramways is not at a cheap rate an immediate general adoption of regenerative control would be warranted on the ground of its economy. In Glasgow, however, the Transport Department have their own electricity generating plant and they obtain the power at a very cheap rate.

IN reviewing a book, entitled "Rediscovering England," Dr. H. E. Armstrong makes the following remarks on education:—"In the school of to-morrow, when education is thought of as a preparation for life, not for an examination, maybe an arrangement will be made with the local Office of Works for the supply, at arranged intervals, of a few cartloads of road-making or building material, together with gravel, sand, and clay. These will be dumped in the playground and thoroughly studied. The various hard rocks will be supplied in big pieces needing to be broken to gauge; children will have an opportunity to learn what stone-breaking involves and what the feel of stones is. Clay, loam, and sand will be dug over and handled. Frequent visits will be paid to local exposures. Bricks will be made. Limestone will be burnt to lime, this slaked, made into mortar, and a wall built. Various rocks will also be studied in the school workshop, not in the superficial way that is now customary, but measured and weighed so far as is necessary to establish their individual characters. Sections will be cut and examined under the microscope; stones will be polished and worn. The classroom will be used mainly for discussions and in writing considered accounts of the work, in amplification of notes taken while it is in progress."

AS opportunity offered, investigations were continued throughout last year by the Sydney Harbour Trust Commissioners with regard to the deterioration of wharf piles and timbers consequent upon attacks by marine organisms. At the various testing stations which have been established at this port, Coff's Harbour, Lismore, and other ports extending as far as Brisbane, much valuable data has already been collected in regard to the life, growth, and habits of the marine borers which exist in the localities named. This research work is being carried out with a view to finding those areas where the greatest intensity of attack by marine organisms takes place; of isolating or appropriating different species to various localities; of ascertaining the species which attack turpentine piles, on which 90 per cent. of the Trust's wharf structures rest; and of devising means of checking the ravages of these creatures. Of all the timbers available for wharfage construction at this port, turpentine has been found to be the most resistant to the attack of marine organisms, but even turpentine, under conditions favourable to the *cobra nausitoria thoracates*, is extremely vulnerable. The further investigations made throughout last year have, however, confirmed the earlier evidence that the depredations of the *cobra nausitoria thoracates* are confined to waters of lower salinity and oxygen content than those in Sydney Harbour.

Miscellanea.

THE members of the International Tin Committee are arranging to organise a campaign of research and development work, on which a sum of £28,000 is to be spent annually.

THREE ships of Elders and Fyffes, Ltd., fleet of fruit-carrying vessels, the "Aztec," "Mazatec," and "Toltec," are to be equipped with Marconi auto alarms and wireless direction finders, in addition to their main Marconi wireless telegraph installations. The direction finders are of the latest type, using the fixed loop aerial system.

AN experimental electrolytical cell for the production of hydrogen and oxygen, operating under a pressure of 200 atmospheres, has been constructed in the laboratories of the Imperial Institute by Messrs. D. M. Newitt and H. K. Sen. Hydrogen of 99·5 per cent. purity can be made in this cell with a saving of some 20 per cent. in the cost of operation, as compared with a cell working under atmospheric pressure.

THE following new Members have been elected to serve on the Council of the British Engineers' Association for the ensuing year :—Mr. J. Carter, of Crossley Bros., Ltd.; Colonel Frank Garrett, of Richard Garrett and Sons, Ltd.; Mr. James Carter Gray, of the Manganese Bronze and Brass Company, Ltd.; Mr. E. G. Liebert, of Johr. Holroyd and Co., Ltd., and Mr. A. Stanley Pye-Smith, of Samuel Osborn and Co., Ltd.

OBJECTIONS are being raised in the Poynton (East Cheshire) district to the erection of overhead electric cables, on the ground that they are an eyesore and tend to depreciate the value of property. Ratepayers have signed a petition, and it has been decided to approach the Rural Council, the Parish Council, and the company which owns the cables. Complaints are also being received from other Cheshire districts, where property owners are demanding the removal of all overhead wires.

CHELTENHAM Town Council has received information from the Unemployment Grants Committee that the Ministry of Labour now approves in principle of the Council's Tewkesbury waterworks scheme for the purposes of a grant for a total estimated cost of £44,284. The Water Committee has agreed to the application of the Mayor of Tewkesbury and Alderman Baker, of that town, that the number of Tewkesbury workmen to be engaged on the scheme should be increased from 10 to 25 per cent.

THE present programmes of standard frequency transmissions on the first and third Tuesday afternoons of each month from the transmitting station 5 H.W. at the National Physical Laboratory, have now been discontinued. They will be replaced by specially modulated transmissions in accordance with a programme which will be announced at a later date. The three-monthly evening transmission on 1785 kc/s. will be continued as at present. Particulars of this transmission can be obtained from the Department of Scientific and Industrial Research, 16, Old Queen-street, London, S.W. 1.

A TESTIMONIAL is given to the petrol-electric crane in the latest annual report of the Sydney Harbour Trust Commissioners. The Trust has four available for hire, two having a lifting capacity of 2 tons each, and two of 3½ to 5 tons respectively. Experience has shown that they are invaluable in dealing with goods which cannot be man-handled, especially in the loading and unloading of wagons and in the stacking and moving of heavy cargoes. Also, owing to their mobility, they are particularly suitable for wharf to road or wharf to wharf transport purposes when dealing with cargo of a heavy or bulky nature.

ACCORDING to *The Times*, the Secretary for Mines has made an Order under Sec. 61 of the Coal Mines Act, 1911, in regard to "permitted" explosives for use in certain classes of mines. The effect is to establish a new schedule of explosives, the use of which is permitted only for the purpose of bringing down coal. The following explosives constitute the schedule :—Antislak, manufactured by Cooke's Explosives, Ltd.; Eversoft L.D. Powder, manufactured by Explosives and Chemical Products, Ltd.; Rounkol and Rounkol No. 2, manufactured by Nobel's Explosives Company, Ltd. The maximum charge of any of these explosives which may be used in any one shot-hole is 18 oz. The Order is entitled the Explosives in Coal Mines Order, January 6th, 1932.

IN the New York metropolitan area, local sections of the American Society of Mechanical Engineers, the American Institute of Electrical Engineers, and other bodies, have established the Provisional Engineers' Committee on Unemployment. The chemical societies have adopted similar measures. An honorary unemployment committee has been formed, the chief function of which is to compile a register of those seeking work, and to undertake a very thorough canvass of industrial firms, &c., for suitable openings. A further important step has been taken at Columbia University, where classes in the engineering department have been opened free to all accredited unemployed professional engineers, the number being limited merely by the size of the lecture halls. A certificate is necessary showing status and confirming that the holder is out of work through no fault of his own.

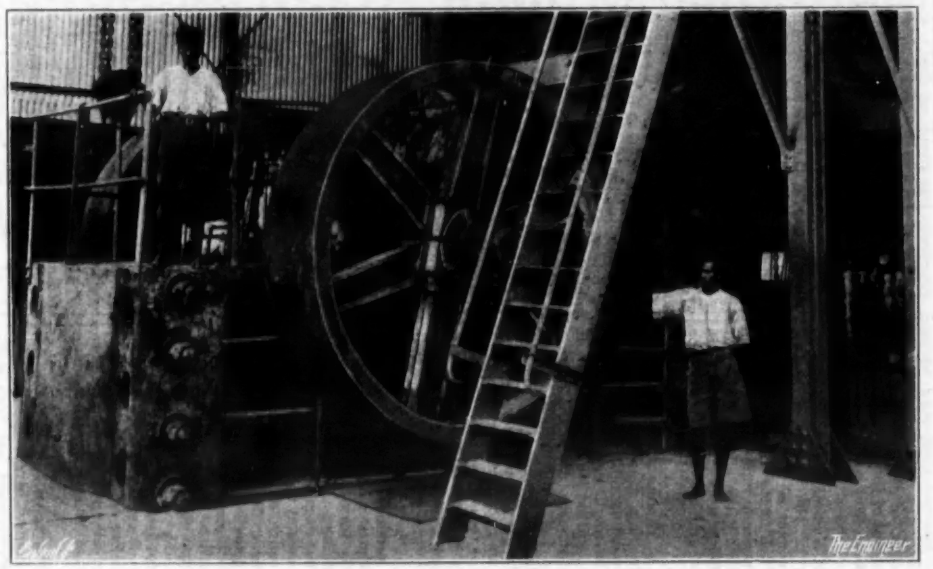
DURING the past three months a more marked demand for telephones for business use has gratified the North-Western District Telegraph and Telephone Advisory Committee, which has issued its annual report. Notwithstanding the check in growth caused by the industrial depression, it says, an increase in lines and stations has taken place. An appreciable increase in the number of business extension lines followed the reduction in rentals. A large number of additional circuits is to be provided between stations in the north-western district and Manchester, and various rearrangements are to be carried out in connection with the scheme for automaticising the Manchester telephone service. It is expected that the alterations will result in a speeding-up of the traffic sent *viâ* Manchester. During the year 13,233 test calls were made on subscribers' premises, and on an average the operators took 5·2 seconds to reply.

PLANT FOR THE PRODUCTION OF CONCRETE AGGREGATE FOR THE CAUVERY METUR DAM

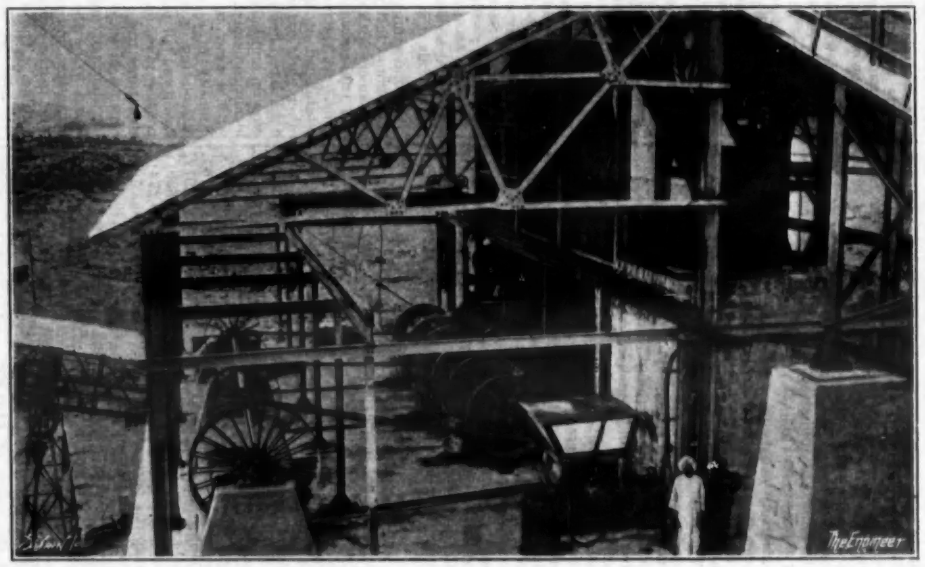
HADFIELD'S, LTD., LONDON AND SHEFFIELD, ENGINEERS

(*For description see page* 166).

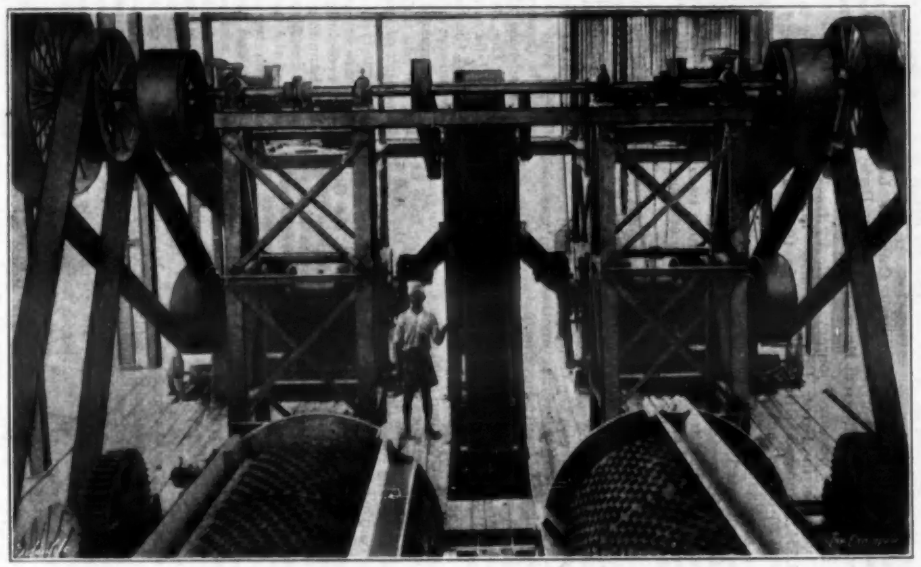
GENERAL VIEW OF THE PLANT



THE SLEDGING BREAKER



INTERMEDIATE CRUSHING PLANT



THE SIZING SCREENS AND DISC CRUSHERS

The Engineer

FEBRUARY 5, 1932.

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Contents.

THE ENGINEER, February 5th, 1932. PAGE

A SEVEN-DAY JOURNAL .. 145
THE EROSION OF STEAM TURBINE BLADES. No. I. (Illus.) .. 146
INSTITUTION OF MECHANICAL ENGINEERS .. 147
BRITISH AND AMERICAN ROLLED STEEL SECTIONS. (Illus.) .. 148
THE TREND OF BRITISH EXPRESS LOCOMOTIVE DESIGN .. 149
THE JUSTIFICATION OF ORGANISED ENGINEERING INSPECTION. No. II. .. 151
THE MECHANISM OF ELECTRIC LOCOMOTIVES. No. I. (Illus.) .. 153
THE PRESENT POSITION OF THE IRON AND STEEL INDUSTRY .. 155
THE INSTITUTE OF METALS .. 156
LETTERS TO THE EDITOR—
Past and Present .. 156
SIXTY YEARS AGO .. 156
RAILWAY AND ROAD MATTERS .. 157
NOTES AND MEMORANDA .. 157
MISCELLANEA .. 157
LEADING ARTICLES—
The Grid and the Electrical Manufacturer .. 159
The Southward Trend of Industry .. 159
Stentor in an Aeroplane .. 160
LITERATURE .. 160
SHORT NOTICES .. 161
BOOKS RECEIVED .. 161
OBITUARY—
E. J. Christian .. 161
W. H. Radford .. 161
A LARGE SCRAP BALING PRESS. (Illus.) .. 163
FRENCH IMPORT QUOTAS .. 164
TWO-FOOT GAUGE LOCOMOTIVE FOR INDIA. (Illus.) .. 164
PORTABLE OIL TESTING SETS. (Illus.) .. 165
MANCHESTER ASSOCIATION OF ENGINEERS .. 165
BOOKS OF REFERENCE .. 165
CONCRETE PLANT FOR THE CAUVERY METUR DAM. (Illus.) .. 166
PROVINCIAL LETTERS—
The Midlands and Staffordshire .. 166
Lancashire .. 167
Sheffield .. 168
North of England .. 168
Scotland .. 169
Wales and Adjoining Counties .. 169
CALENDARS .. 169
PERSONAL AND BUSINESS ANNOUNCEMENTS .. 169
CATALOGUES .. 169
CURRENT PRICES FOR METALS AND FUELS .. 170
FRENCH ENGINEERING NOTES .. 171
BRITISH PATENT SPECIFICATIONS. (Illus.) .. 171
FORTHCOMING ENGAGEMENTS .. 172

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THE "GRID" AND THE ELECTRICAL MANUFACTURER.

THE arguments of the opponents of the British "grid" have been pretty well balanced by the claims of its supporters. Admiration for the scheme has emanated mainly from politicians, the Electricity Commissioners, consulting engineers, and the Central Electricity Board, which is faced with the difficult task of making the scheme pay. The claims of engineers, however, have been much less extravagant than those of the less well-informed politicians, who for the most part have talked sheer nonsense. In his presidential address, delivered before the Institution of Electrical Engineers in 1927, Sir Archibald Page gave a list of some of the things the grid would not do. It would not, he said, appreciably improve the efficiency of generation in the areas of certain of the power companies and larger municipalities; it would not reduce the price of electricity for lighting in large cities, nor would it create an electrical heaven, and give "ninepence for fourpence." But the "grid" would go a long way towards ensuring universal availability of electricity throughout the country. Bearing in mind the position which Sir Archibald holds, his claims for the National Scheme were moderate, and his remarks were devoid of the catch phrases in which others have thought fit to indulge. From the large electrical manufacturers' point of view, the "grid" has proved a boon, because it has enabled them to tide over difficult times and to give employment to many workers who might otherwise have been drawing the dole. As a means of keeping the wheels turning, the National Electricity Scheme has served a useful purpose, although it would have been better for the country if the firms concerned had been engaged on work for abroad. The grid work amounts to nothing more than what is known as "taking in one's own washing," and the electrification of main line railways would come within the same category.

When the "grid" contracts come to an end, the demand for electrical equipment in this country will depend largely on the industrial conditions and the efforts made by local authorities to obtain new load, for it is scarcely conceivable that the main line electrification scheme will be put in hand. The generosity of the Government in placing so much remunerative work in the way of the large electrical manufacturers will soon be forgotten, unless an adequate demand for consumers' equipment is forthcoming. One of the principal objects of the National Scheme is to reduce the amount of spare generating plant which under the old scheme would have provided work not only for the largest electrical firms, but also for manufacturers who do not possess the necessary equipment for the construction of super-power station sets. Many more generating units would have been required under the old scheme than will be needed under the new, but against this loss of business the fact must, of course, be set that the greater availability of electricity should lead to much new work in other directions. The angle from which the manufacturer views the National Electricity Scheme is governed largely by the kind of plant or apparatus in which he happens to be interested. We have yet to meet an oil engine maker who can find much merit in the scheme, or a maker of transmission line equipment who does not believe that the idea of interconnecting power stations is thoroughly good. Mr. W. A. Coates, who read a paper on "The British Grid System," before the Belfast Association of Engineers last Wednesday described the scheme as a magnificent conception, and, as a switchgear engineer connected with a firm that has supplied a large amount of gear for the job, he, no doubt, believes what he says. No one has better reason to be thankful for the National Electricity Scheme than those who are associated with the manufacture of switchgear, for, apart from the large amount of gear required for the "grid" itself, many who are having their plant linked up with the 132-kV lines are finding that their existing switchgear is altogether inadequate to deal with possible short circuit currents, and are having to install new and more expensive gear. But even Mr. Coates seems to be a little anxious about the prospects of success, or, at any rate, he appears to doubt if the scheme will pay within the allotted time. It was originally expected, he states, that the scheme would have begun to justify itself by 1941, but as events are shaping this was probably rather optimistic. Mr. Coates might have added that the cost of frequency standardisation was originally estimated at eight million pounds, but the sum has since been increased to over eighteen and a-half million pounds. Much additional load is needed, but until general conditions improve and supply undertakings become abnormally active, it is difficult to see how it is to be procured. No one can, of course, be blamed for not foreseeing the change in industrial conditions, but that does not make the outlook any more rosy.

Nevertheless the new experience which the manufacturers have acquired in carrying out "grid" contracts should place them in a good position to secure similar work in Northern Ireland and elsewhere. No longer can it be said that British electrical engineers are inexperienced in the erection of high-pressure transmission lines, the manufacture of large transformers with on-load tap-changing gear, or the construction of high-capacity outdoor switchgear. The protective gear for the "grid" has presented special problems to designers of protective apparatus, and new schemes have been devised. Similarly, metering has given rise to the development of special metering systems to enable the conditions set forth in the 1926 Act affecting the sale and purchase of electricity to be met. While it would be scarcely right to assert that the "grid" has caused manufacturers to break new ground in every direction, it has undoubtedly provided them with a good deal of new experience. Soon after the war several firms began to build apparatus similar to that used on the "grid" for places abroad, but in relatively small quantities. That technical troubles have been experienced is well known, and few can grapple with troubles without adding to their knowledge. The difficulties which electrical manufacturers will have to face in the future will not be on the technical side of the business, but rather in the direction of finding scope for utilising the new experience they have acquired.

The Southward Trend of Industry.

DURING the closing years of last century and in the early years of this there was a decided movement of industry away from London and its neighbourhood. The movement was particularly noticeable in the shipbuilding industry. Woolwich dockyard was closed, Thornycroft's left the Thames for Southampton, Yarrow's forsook Poplar for the Clyde, and when the Thames Ironworks shut its gates in 1913 after completing H.M.S. "Thunderer," the once famous and extensive shipbuilding activities of London River came to an end. These events were spectacular, but in other directions the departure of industry from London, although less noticed, was quite definite. High local taxation was not the only cause at work. The congestion of the London area cramped the room required for expansion, added to the cost of transport of raw materials and finished goods, and rendered difficult the satisfactory housing of the workers. In short, London had outgrown itself and had ceased to provide the conditions encouraging the establishment of new or the growth of existing industries within its bounds. Within recent years this movement has ceased and a decided reaction has set in. Government statistics have for some time past shown that there is a strong and steady tendency for industry to move south, and, as everyone may see for himself, the metropolitan area—using the term in a loose but wide sense—is attracting a very large portion of the inflow. Two main factors seem to be contributing to this southwards trend. In the first place, the conditions which twenty or thirty years ago caused industry to forsake the London area have since arisen in many of the manufacturing centres in the North. Secondly, improved transport facilities in and around the Metropolis have opened up many new industrial districts and have made it practicable for factories to be established at a considerable distance from their head offices and for the workers to live remote from their places of employment.

Under the direction of Sir Hubert Llewellyn Smith a committee of the London School of Economics and Political Science began in 1928 a new survey of London life and labour. When completed, the work will reveal the changes that have occurred since Charles Booth and his colleagues, some thirty-six to forty years ago, prepared a similar survey, which was published under the title of "Life and Labour in London." The second volume of the new survey has recently been issued and is of particular interest to us because, among the various branches of activity with which it deals, it includes the engineering and metal working industries. No one who studies the volume can fail to appreciate the thoroughness and care which have been spent on its compilation and the diligence with which the authors of it have sought to obtain trustworthy and valuable information and statistics. Yet as a picture of the real position of London and its neighbourhood from the industrial point of view the volume has its shortcomings, and in some important respects may prove misleading. In places the compilers have been compelled to rely on figures which are clearly out of date, namely, on data obtained from the Industrial Census of 1921. Very much has happened during the past ten or eleven years to render those figures of doubtful value as an indication of present conditions and tendencies. Wherever possible, it is true, they have been supplemented by statistics and estimates relating to more recent years, but the net result is a little unsatisfactory, in so far that the survey is less a plan than a perspective extending a decade in depth. It is, too, something more than a little unsatisfactory by reason of the circumscription of the area to which it relates. That area covers the City of London and thirty-seven of the surrounding boroughs; that is to say, an area less than half that to which the name "Greater London" is commonly applied. Many important industrial districts are in this way omitted from the survey. Croydon, Erith, Dagenham, Enfield, Barnet, Wembley, Edgware, Brentford, Kingston and Staines are among the areas excluded. No picture of the existing industrial position of London and its neighbourhood could be complete or, indeed, could be other than misleading with these omissions. We would go further and say that the industrial undertakings that have been established along the Great Western line as far down as Slough and even the many and important works which have found a home at Letchworth belong geographically and by their commercial associations to the London area. Even although we confine ourselves to the territory known as Greater London, we have to note that as long ago as 1921, 25 per cent. of the engineering and metal workers within that territory resided outside the thirty-seven boroughs surrounding the City. It is in the outer and outlying districts that the true development of London as an industrial centre is to-day taking place. It is in them and not in the congested inner area that the manufacturer finds low rates, room for expansion, and satisfactory facilities for the housing of his workpeople.

A survey of the inner area from the point of view of the engineering and allied industries shows London to be very largely devoted to repair work and to be distinguished by the large number of small establishments which it contains. That picture is true for the very sharply defined area to which it relates. It is not, however, true as a representation of the conditions existing in Greater London and its surroundings. An arbitrary boundary limiting the area surveyed cannot fail to present a distorted view of the position. How misleading the picture may be is illustrated by the case of the aeroplane industry. Within the London area surveyed by the Committee of the School of Economics there is but one firm engaged on the manufacture of aeroplanes. Yet if the area be extended to include Croydon, Kingston, Edgware, Weybridge, and Hayes it will be found that over one-quarter of the whole of the country's aeronautical industry is centred round London.

The war added Slough to the industrial areas of the South, the enterprise and vision of the town planners gave us Welwyn and Letchworth, the British Empire Exhibition left Wembley behind it, Mr. Ford for his own reasons has established himself at Dagenham, the construction of the Great West Road has opened up the Brentford district, and down the river between Erith and Dartford works have replaced the homes of City magnates. These places belong to the London industrial area and must be included in any survey of it which is to possess any value as an indication of present tendencies or as a record for future reference. Admittedly the area is large and not clearly defined, but without particularising its exact limits and without delving deeply into detail we can assert as an outstanding truth that the surroundings of London are proving increasingly attractive to manufacturers of an extremely wide range of products and are gaining industrially at the expense of the North. From many points of view, social, political and economical, the position is interesting. How long will the movement of industry southwards and Londonwards last and where will it end? Is it desirable nationally that it should continue for an indefinite period and in an uncontrolled manner? Have we in the past suffered from an unbalanced distribution of industry, and is the movement to the South an unconscious effort to rectify it? These and many other questions suggest themselves as fitting subjects for study by people with the leisure and ability and the breadth of vision required to investigate them. Politically, industrial Britain is to-day at a turning point in its history. Geographically, it would seem, a change is also on the way. Both may play an important part in determining our future prosperity.

Stentor in an Aeroplane.

WE had thought that the prerogative of inventing new and more universal methods of disseminating news and knowledge of one kind or another was pre-eminently American. The mistake was ours. In Milan, so we are told, experiments are being conducted with a "talkie" aeroplane in the presence of interested authorities. The machine is fitted with four amplifiers, and music, the human voice, and any other desirable or undesirable sounds can be transmitted from the aeroplane to people on the ground. Each loud-speaker has no less than nine diaphragms, and the magnification makes the normal human voice sound so loud that the noise produced by the engine becomes almost insignificant. Flying at an elevation of 3300ft., music played in the cabin of the three-engined aircraft can be heard plainly and distinctly by people on the ground within a radius of 1½ miles. Stentor himself would be proud of such a feat. The Italians have surpassed our cousins across the Atlantic. So far, it is true, they have made no attempt to disseminate knowledge of any particular brand. The experimenters have confined their activities to the transmission of music with occasional interludes of human speech. A popular song, we are told, was broadcast and heard distinctly on the ground. Nevertheless, the possibilities of development are there. Nowadays it does not take long for a new device to pass from the stage of experiment to that of commercial development, and in a short time we must expect to be adjured by voices from the clouds to buy Sog's soap in preference to any other brand or by subtle confidences imparted by soft whispers from the starry heavens be beguiled into believing that Thinwhistle Mixture is the better smoke! The possibilities are great. This form of advertising will be universal in its action. The public cannot but listen. People on the earth beneath will not be able to pass it by unnoticed as the brilliantly coloured poster on a hoarding, or skip it as they can the advertisement pages of the Press. No receptive device is required save the human ear alone, so that the turning of a switch will not be sufficient to shut out the odious voice. In self defence the public will have to build itself sound-proof rooms or retire into the tubes. No doubt the installation on the aeroplane is most ingenious. No doubt, again, the engineers have excelled themselves in skill and the use of artifice. Each amplifier, we learn from the meagre details available, is supplied with current by an aerial dynamo driven by a small air-screw mounted on the wings, and the sound of the normal human voice is magnified 1,600,000 times. To magnify a voice so much and yet retain the distinctness of the syllables is indeed a great feat, but to what end is all this ingenuity? There is noise enough in the world without thus adding to it. Happily, the apparatus must be expensive, and when to this expense is added that of running the aeroplane, it may well be that the method of advertising we have sketched may prove too costly. In that case there is still hope that sound-proof rooms may not be necessary and that jerry-built houses may not be disintegrated by reverberations.

Literature.

The Roeblings: A Century of Engineers, Bridge Builders and Industrialists. By HAMILTON SCHUYLER. Princeton: The University Press. London: Humphrey Milford. 1931. Price £1 6s. 6d.

THIS is the story, covering more than three generations, of a remarkable family. Nearly the whole of the scene is laid in the United States of America, though the history begins with an account of the ancestry, relations, and early life of a German youth named Johann August Roebling, who was born on July 13th, 1806, at Muhlhausen, in Thuringia. His father had two other sons, Friederike Amalia and Karl Meissner, Johann August being the youngest of the three. It will not be necessary to go in detail into the latter's education; it will suffice to say that, after receiving a good grounding as an engineer, and paying particular attention to bridge construction, the young man worked for the Prussian Government during three years as an assistant in building roads in Westphalia. Finding, however, that the then economic conditions in his native land did not afford adequate opportunity for advancement, he at length determined to emigrate to America. Accordingly, having made a very complete book study of that country, John A. Roebling—as he was to be known for the remainder of his life—collected funds for investment in the new land, and organised a party of colonists, a member of which was his elder brother Karl. The two brothers left home in May, 1831, and neither of them was destined ever to return to the Fatherland. The locality finally chosen for the establishment of the colony was 25 miles from Pittsburgh, and the names given to it were, first of all, Germania, and afterwards Saxonburg. That place saw the beginnings of what was to become a business of vast proportions.

We cannot spare space to recount in full the fortunes met with by the adventurers and their descendants, as revealed in the three sections of the book:—I., John August Roebling; II., Washington Augustus Roebling; III., Ferdinand William, Charles Gustavus and the Third Generation. We can only deal with them in broad outline. The original intention was to farm some of the land acquired and to sell other lots of it to prospective settlers from Germany, and, eventually, many were attracted to the spot. The farming was pursued with more or less success for some time, but John did not long remain content with it. After six years he applied for and obtained employment by the State as an engineer. In the same year, 1837, he became a naturalised citizen of the United States. From that time onward until his death, thirty-two years later, he was ceaselessly occupied with engineering constructional work. It early occurred to him to substitute wire ropes for the hemp hawsers, which had been used up to that time for hauling cars up portage inclines between two canal systems constructed at different levels, or conveying them up and down over high land which might intervene between two such systems. No one had, so far, made wire ropes in the United States, though they had been produced in Germany. John set to work to devise and put in operation at Saxonburg the machinery to manufacture them. The undertaking was successful, and one of the first applications of these new ropes—which at first were made of the purest iron wire obtainable—was the cable suspension of an aqueduct. Shortly afterwards—1845–1846—John built the Monongahela suspension bridge, a structure of eight spans of 188ft. each. From that time onwards his life was devoted to the design and construction of bridges, all of them of the suspension type. Among the more important bridges attributable to him are those at Niagara Falls and at Covington, and that over the Allegheny at Pittsburg. The main span of the Covington Bridge, it may be mentioned in passing, was as much as 1057ft. It was he, too, who reconstructed and strengthened a suspension bridge over the Ohio River at Wheeling, West Virginia—a structure with a central span of 1010ft.—which had been built by one Charles Ellet, and which had been seriously damaged by a tornado in 1854. The Niagara Bridge, which he completed in 1854, was claimed to be the first wire cable suspension bridge capable of bearing the weight of a moving locomotive and train. Perhaps his greatest achievement—had he lived to complete it—would have been the Brooklyn Bridge over the East River at New York, the feasibility of building which he was the first to point out. He was, in fact, appointed Chief Engineer for the work, for which he himself got out the designs, and he had actually begun constructional operations when he met with an accident which ended fatally. It was another member of the family who carried the enterprise to a successful termination.

For the bridge building, as well as for numbers of other purposes, including lift suspension, mine haulage and winding, cable haulage, ships' rigging and tackle, &c., there was a continuously increasing demand for wire rope. To meet it, the works at Saxonburg were extended. Then a move was made to Trenton, so as to obtain additional transport facilities, while, later, further factories were established elsewhere. Wire, too, began to be increasingly used in other directions, such as for telegraphy, wire cloth, the transmission of electricity, &c. For the latter use, since copper was a necessity, special machinery had to be provided. In the earliest days the iron wire was bought; later, the firm drew its own. Then it put down plant for the manufacture of steel from which to make wire, and machinery for rolling the necessary rods, and, later still, plant for galvanising the wire. In later years the complete construction of bridges was discontinued, the company confining its work to the supply of wires and wire ropes and cables, and to the placing of the cables in bridges when the necessary supports had been built. Its latest achievement was the manufacture and successful spinning of the cables for the giant George Washington Bridge.

These are just a few of the activities of the John A. Roebling's Sons' Company, which to-day is one of the leading commercial undertakings in the North American Continent, as told in the volume. The book goes with great minuteness into the various fortunes experienced by the firm, its continued expansion and of the greater and greater magnitude of its operations. We must, however, leave it to the reader to learn with how great thoroughness the author has carried out his self-imposed task. He has done far more than follow the progress of a successful manufacturing company; he has drawn, as well, many realistic pictures of the home lives, characters, and occupations of many bearers of the name of Roebling, and others. The book will, we are sure, be read with interest by many who have no technical knowledge, as well as by those engaged in bridge building, and other engineers.

Hydro-Electric Development in the British Empire. By J. E. ROBBINS. Toronto: The MacMillan Company, of Canada, Ltd. 1931. 5s.

THIS book was written because it was felt that the development of the Empire as one economic unity is attracting very considerable attention at the present time, and that a survey of its resources might in the circumstances have considerable importance. The author, Mr. Robbins, and Professor Humphrey Michell and Professor Kenneth W. Taylor, both of whom directed the work—all of McMaster University, in Canada—felt that it would be futile to arouse interest abroad in a type of undertaking in any sense foreign to Canadian knowledge and initiative, and the hydro-electric industry was chosen for survey as one in which Canadian capital and enterprise have been eminently successful, both at home and further afield. The book, then, is a survey of the hydro-electric resources developed and undeveloped throughout the British Empire.

The volume is small, containing less than 150 pages, but within this space all the more important possessions within the Empire are examined. Thus it suffers from compression, and is more suitable for reference than for reading. Due praise, however, must be given to the author for the amount of work which its compilation must have entailed, for information from all parts of the world had to be collected and sifted.

Reading the book, the reflection was forced upon us that the question of whether a country's water power resources are developed or not depends upon many more factors than the economic ones. There are comparatively few places in the world in which possible resources of water power are placed conveniently close to the consumer of the power to be developed. In this respect, Canada is very favourably situated. Suitable sites for power stations are scattered far and wide over the country, and practically every large city is already supplied with power from a hydro-electric station, or has a possibility of developing power in this manner from a nearby falls. Estimates based on ordinary six months' flow place the available power conservatively at 33,617,000 horse-power, but no account is taken of many possible sources for which reliable data have not been gathered.

A glance at the map contained in the book, showing the sites of developed or undeveloped water power, demonstrates that all the industrial districts have plenty of available power, while even the Prairie Provinces are not ill-provided. Saskatchewan, for instance, has estimated hydro-power resources of over 1,000,000 horse-power at ordinary six months' flow.

Not every country is so well placed. The resources of Australia are almost confined to the region of the Australian Alps and Tasmania. Out of the 4,500,000 H.P. available, 3,500,000 H.P. is situated in the smaller island. Many of the British Colonies in Africa, although plentifully supplied with available water power, are hindered from using it owing to various causes, the chief of which is the remoteness of the available sources from the power-consuming districts.

The impression conveyed by the book is that many difficulties must be overcome before the water power resources of the Empire can be developed to anything like the fullest possible extent. In many countries, of which England is perhaps the most notable within the Empire, the supply of water to towns has the first call upon the water in the land. Much of the possible water power of Wales cannot be used for power on account of this consideration. In other places, although the demands of supply which apply in highly developed countries such as England are not dominant, the water is required for irrigation purposes first and foremost. Such considerations apply to large parts of India and, to a lesser extent, to Africa and Australia. Even where these two dominant considerations do not trouble the prospective developer of hydro-electric power, it is frequently found that the available source is situated in a district inhabited by a native population, and there is no prospective demand for power in sight. The situation may at the same time be too far from any consuming region to make its development profitable. In Africa, in many cases, the power is available, but the construction of the storage lakes necessary if power is to be supplied throughout the year, and not only in the rainy season, would be so costly as to make the undertaking economically unsound, while in other places no natural storage basin is discoverable. Many of the rivers in Australia are capable of providing power when in spate, but the droughts are so long continued and so variable in length that no reliance could be placed on power being continuously available, even should it be possible to provide large storage capacity.

Yet, when due allowance is made for all these disabilities, it must be admitted that much might be done to develop those resources to which they do not apply. Within the Empire a total of 7,566,300 horse-power of hydro-electric energy was in use at the end of 1930, of which Canada absorbed 6,125,000 horse-power. Even in the Dominion, however, only about 14 per cent. of the recorded horse-power is in use, and in other parts of the Empire it is far lower. In British Guiana, the Gold Coast, and British New Guinea, the potential power is estimated to be between 15 and 20 million horse-power, and remains intact. In many districts, notably large regions of South Africa, the deterrent to the development of otherwise suitable water power sources is cheap coal, but in others the author of the book considers that hydro-electric energy will find its field of utility expand as the Empire becomes more industrialised.

The Physics of High Pressure. By P. W. BRIDGMAN, Ph.D. London: G. Bell and Sons, Ltd. Price 22s. 6d. net.

THIS is another volume of that excellent series of "International Text-books of Exact Science," edited by Professor E. N. da C. Andrade, for which we are indebted to the enterprise of G. Bell and Sons. Professor Bridgman is well known for his extensive work on high-pressure phenomena, and this book supplies a complete and very welcome survey of the subject. In it the author describes his own work and also that carried out by other investigators.

The first chapter contains an historical account of the early development of this branch of physics. The most important work was that done by Amagat, which terminated in 1893. He investigated the effect of high pressure (some 3000 kilos./cm.^{2}) on the compressibility of gases, liquids and solids. Some work on the same subject had already been done by Roentgen and others, but using much lower pressures. Subsequently, the subject was investigated by numerous workers, culminating of course, in the author's own experiments. At the end of this chapter there is a very complete and interesting bibliography of all the early work, commencing with a reference to the *Phil. Trans.* of 1762 concerning the experiments of Mr. John Canton "to prove that water is not incompressible."

For the experimental physicist who is interested in the practical investigation, the second chapter is of great value, for in it Professor Bridgman is at pains to describe his technique in detail with interesting remarks about the difficulties that led to the modifications in apparatus which were ultimately overcome. The difficulties may be imagined when we read that the author has achieved pressures of 750,000 lb./in.^{2}. Following this is a chapter dealing with the measurement of high pressure, again illustrating the development of modern technique.

From the point of view of the engineer the subject in general is of considerable practical interest, and the next chapter is important in that it deals with mechanical rupture due to high pressue. The analytical account of the failure of steel containers and various parts of high-pressure apparatus is particularly significant and useful as a record of personal experience. It will be appreciated by the engineer who is associated with hydraulic testing.

The succeeding chapters are devoted to specialised investigations, all of which are described in considerable detail: P.V.T. relations in Fluids, Compressibility of Solids, Melting Phenomena under Pressure, Electrical Resistance of Metals and Solids, Thermal Conductivity under Pressure and Viscosity. This selection of chapter headings conveys some idea of the comprehensive nature of the work and suggests the wide interest of the subject. The final chapter on "Miscellaneous Effects of Pressure" contains many interesting notes, such as the effect of high pressure on rigidity, surface tension, and di-electric strength, all points of considerable practical significance. A noteworthy feature of the book is the excellence of the bibliography and the copious references. It must be regarded as a standard work on the subject and as an essential volume in every scientific and engineering library.

SHORT NOTICES.

Handbooks of the Science Museum. Land Transport, III.: Railway Locomotives and Rolling Stock: Part I., Historical Review. Price 2s. 6d. *Part II., Descriptive Catalogue.* Price 2s., both by E. A. Forward. Published by H.M. Stationery Office.—It is now generally recognised that, if the full benefits of a museum are to be made available to the general public, a review of the history which surrounds the objects exhibited is essential. The catalogue alone is sufficient for those already familiar with the subject, and is, of course, an absolute *sine qua non*; but, even though the specimens be arranged in chronological sequence, they will remain nothing more than objects of curiosity to the uninstructed observer. The need of an historical survey has long been appreciated by the Directors of the South Kensington Museum and in old catalogues useful notes may be found, but more recently greater attention has been paid to the matter and several excellent reviews have been issued. The latest is that on "Railway Locomotives and Rolling Stock," prepared by Mr. E. A. Forward, whose knowledge of the subject is unsurpassed. In the space put at his disposal he has called attention to the principal inventions of each decade since Trevithick, whom he rightly acknowledges as the father of the steam locomotive, produced his famous engines in the very first years of the last century. Both this "Historical Review" and the "Catalogue" are well illustrated, and excellently produced. They are well worth their price, yet we fear that the number of purchasers, of the Review particularly, will not be as high as it ought to be, and the publication of a cheaper edition, say at the price of 6d., is, we suggest, very desirable.

Properties and Mechanics of Materials. By P. G. Laurson and W. J. Cox. London: Chapman and Hall, Ltd. 12s. 6d.—In writing this book, especially designed for the use of students, the authors have had in mind the desirability that the reader should secure a good working grasp of fundamentals rather than a general smattering of many things. They claim in the Preface that with good knowledge of such a kind the student can later approach specialised cases without fear. From their own experience of what a student requires and what undergraduates find most difficult to assimilate, the authors have made an effort to proportion the various parts of the book in such a way that the knowledge attained shall be thoroughly well understood. The first four chapters of the book deal at some length with the materials of engineering and their general properties, but the remainder—there are eighteen chapters in all—deals with all the various problems met with in calculations of stress in beams, shafts, columns, riveted and welded joints, &c. A number of pages at the end are given up to appendices dealing with the differential calculus, centroid and statical moment of a plane area, the moment of inertia of a plane area, derivation of Euler's formula for long columns, and a number of tables, many of which, being based on American standards, are of limited use in this country.

Kidder-Parker Architects' and Builders' Handbook. Eighteenth edition. London: Chapman and Hall, Ltd. 50s.—This invaluable handbook was last completely revised and enlarged in 1915, when the sixteenth edition was published. Although in the two following editions certain chapters were revised or enlarged, no considerable alterations were made. In this, the eighteenth edition, the advent of improved methods of construction and new materials, combined with alterations in building costs and other changes, has necessitated a thorough revision. The reader will find that much of the matter included in earlier editions has been omitted, while of those chapters which still remain many have been subjected to searching alterations. In place of those which no longer appear in the handbook new chapters have been introduced, while, with the object of increasing the usefulness of the book, the Index has been rearranged. Although so much has been altered, users of the handbook will be glad to learn that the original arrangement has been retained.

Mechanical Testing. By R. G. Batson and J. H. Hyde. Volume I., *Testing of Materials of Construction.* London: Chapman and Hall, Ltd. 21s.—This is a second and enlarged edition of a book first published in 1922 and belongs to the invaluable D.U. series. The volumes of this series are so well known that there is little need to say more here than that this book describes a very large variety of tests from ordinary commercial to laboratory, and from the simple tensile tests to various others reproducing as nearly as possible in the laboratory the conditions the material must undergo in service. Considerable progress has been made in recent years in the standardisation of methods of testing and in the development of new methods, particularly of fatigue testing and carrying out investigations of the behaviour of materials at high temperatures. By the issue of this new edition the work has been brought up to date with these developments.

Memories and Monuments in the Streets of the City of London. By A. K. Bruce. London: Methuen and Co., Ltd. 1931. Price 7s. 6d. net.—This volume is really outside our scope, but as it was written by an engineer and the son of an engineer we desire to offer it a welcome. Engineers are generally charged with being too closely wrapped up in their own affairs. Mr. Bruce shows in this volume that they may have larger interests and an ability to present them in a pleasant guise. He leads us through the principal streets of the City, and about each he finds some anecdote to recall or some interesting fact to recount. Those outside the City, even Londoners, know little about it, and Mr. Bruce's volume, which will slip into the pocket, will prove invaluable to them, whilst the foreigner may learn from it easily and rapidly much for which he would have to dip deeply into larger works.

BOOKS RECEIVED.

Central Heating and Hot Water Supply for Private Houses. By G. C. Sanford. London: Crosby Lockwood and Son, 7, Stationers' Hall-court, E.C. 4. Price 8s. 6d. net.

Artificial Earthing for Electrical Installations (Automatic Safety Switching). By T. C. Gilbert, A.M.I.E.E. London: Ernest Benn, Ltd., 154, Fleet-street, E.C. 4. Price 9s. net.

The Concrete Year Book, 1932. Edited by O. Faber, O.B.E., D.Sc., and H. L. Childe. London: Concrete Publications, Ltd., 20, Dartmouth-street, S.W. 1. Price 3s. 6d. net.

Beiträge zur Geschichte der Technik und Industrie. Volume 21, 1931–1932. Edited by Conrad Matschoss. Berlin: V.D.I.-Verlag, Dorotheenstrasse 40, N.W. 7. Price 10·80 marks.

Annali dei Lavori Pubblici (già Giornale del Genio Civile), Ministero dei Lavori Pubblici, Consiglio Superiore. Anno LXIX., Fasc. No. 9, Settembre, 1931. Rome: Provveditarato Generale dello Stato, Libreria.

Symposium on Welding. Held at the Pittsburg Regional Meeting of the American Society for Testing Materials. Philadelphia: American Society for Testing Materials, 1315, Spruce-street, Pa., U.S.A. Price 1·75 dollars net.

The South and East African Year Book and Guide, 1932. Edited by A. S. Brown, F.R. Met. S., and G. G. Brown, F.R.G.S. London: Union-Castle Mail Steamship Company, Ltd., 3, Fenchurch-street, E.C. 3. Price 2s. 6d. net.

Vector Analysis with Applications to Physics. By Richard Gans. Authorised translation from sixth German edition by W. M. Deans, M.A., B.Sc. London: Blackie and Son, Ltd., 50, Old Bailey, E.C. 4. Price 12s. 6d. net.

Die Elektrischen Maschinen. Vol. I.: Allgemeine Grundlagen. Vol. II.: Konstruktion und Isolierung. By Dr.-Ing. M. Liwschitz and Dipl.-Ing. H. Glöckner. Leipzig: B. G. Teubner. Price, Vol. I., 18 marks; Vol. II., 19 marks.

OBITUARY.

EDMUND J. CHRISTIAN.

BY the death of Mr. E. J. Christian, which occurred on January 27th at the age of sixty-three, after a brief illness, at his home in Altrincham, a familiar figure in Manchester engineering circles has been removed. Mr. Christian was for many years associated on the technical side with the Linotype Company, Altrincham. Subsequently he was on the staff of Joseph Adamson and Co., of Hyde, for some time, and more recently was a director of Sutcliffe Brothers and Bryce, of Hyde, which firm is now amalgamated with Newall's Insulation Company. For some years and until his death Mr. Christian acted as honorary treasurer of the Manchester Association of Engineers, and he was also a member of the Committee of the North-Western Branch of the Institution of Mechanical Engineers. In both of those offices Mr. Christian performed his duties with characteristic thoroughness, and his death will be regretted by a wide circle of friends.

MR. W. H. RADFORD.

WE regret to have to announce the death of Mr. W. H. Radford, of Nottingham, which took place at his home on January 31st. Mr. Radford retired from the profession six years ago, when his health began to fail, but he will still be remembered by many who came in contact with him on the numerous public works schemes which he carried out.

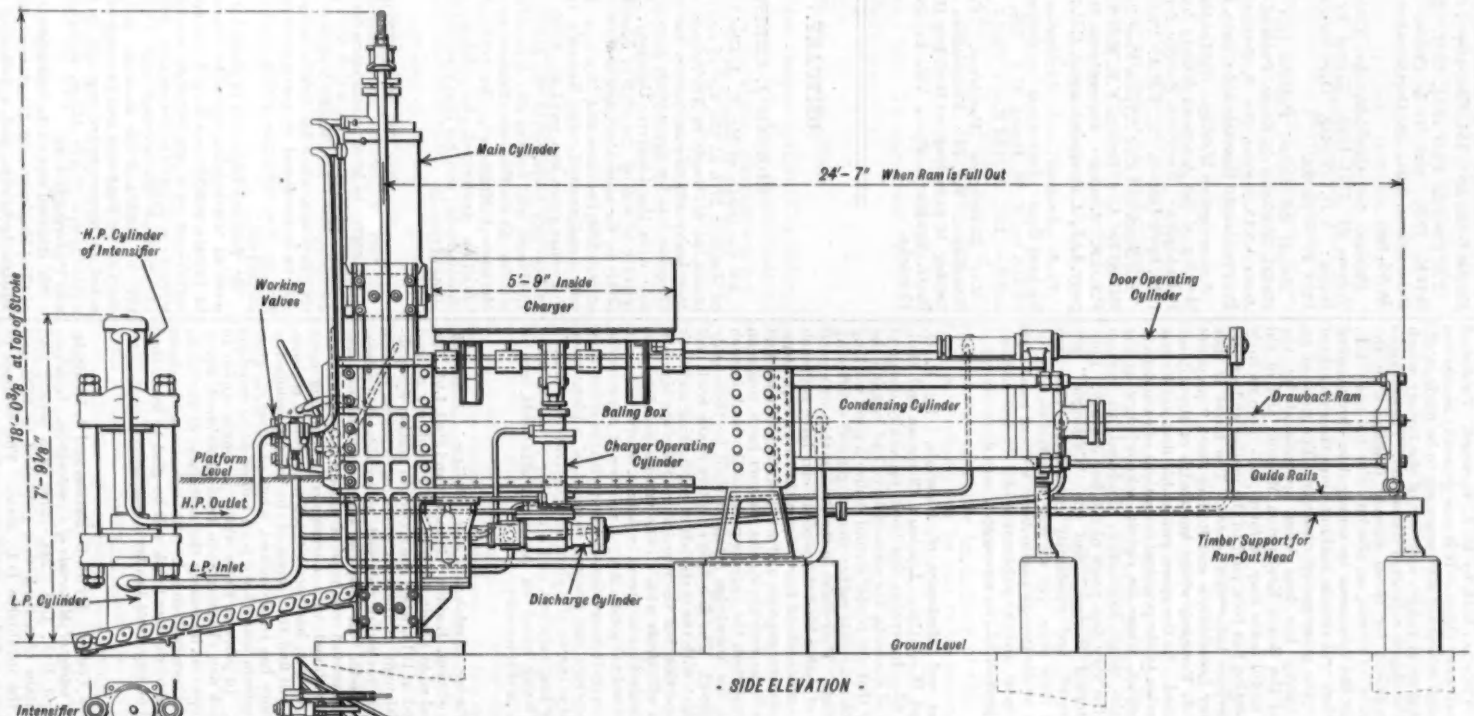
Mr. Radford began his professional career in municipal work at Nottingham under Mr. Tarbottom. He started in private practice as a civil engineer about 1885, and carried out over one hundred sewerage and waterworks schemes in all parts of the country, perhaps the best known of which are the sewerage and sewage disposal for the City of Bath and the sewerage and sewage disposal of the City of Rochester and Borough of Chatham. He also acted as representative engineer in England for several authorities in South Africa, including Durban, Pretoria and Pietermaritzburg.

Mr. Radford was an Associate Member of the Institution of Civil Engineers, an Associate of the Royal Institute of British Architects, and a Fellow of the Royal Sanitary Institute. In 1912 he was joined by his son, Mr. W. N. Radford, who, since his father's retirement, has carried on the firm now known as W. H. Radford and Son.

A LARGE HYDRAULIC SCRAP BALING PRESS

ROSE, DOWNS AND THOMPSON, LTD., HULL, ENGINEERS

(For description see opposite page).



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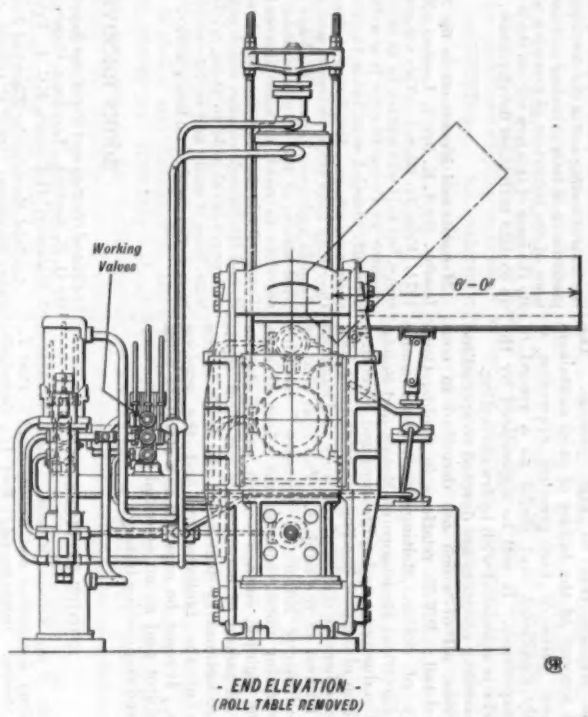

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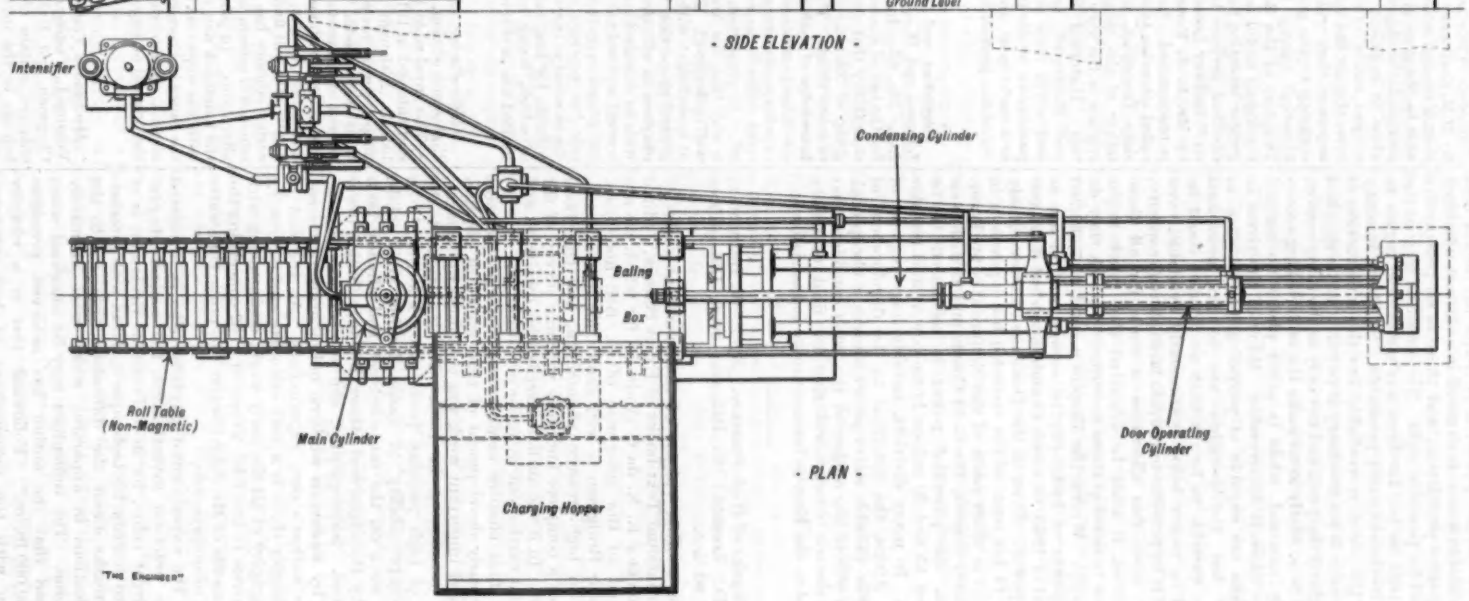


- PLAN -

Press Box 2'-4" x 3'-0" x 7'-9"

Size of Bale Approximately 2'-4" x 1'-4" x 1'-4"

Overall Length 32'-9"

Overall Width 14'-0"

Overall Height 18'-1"

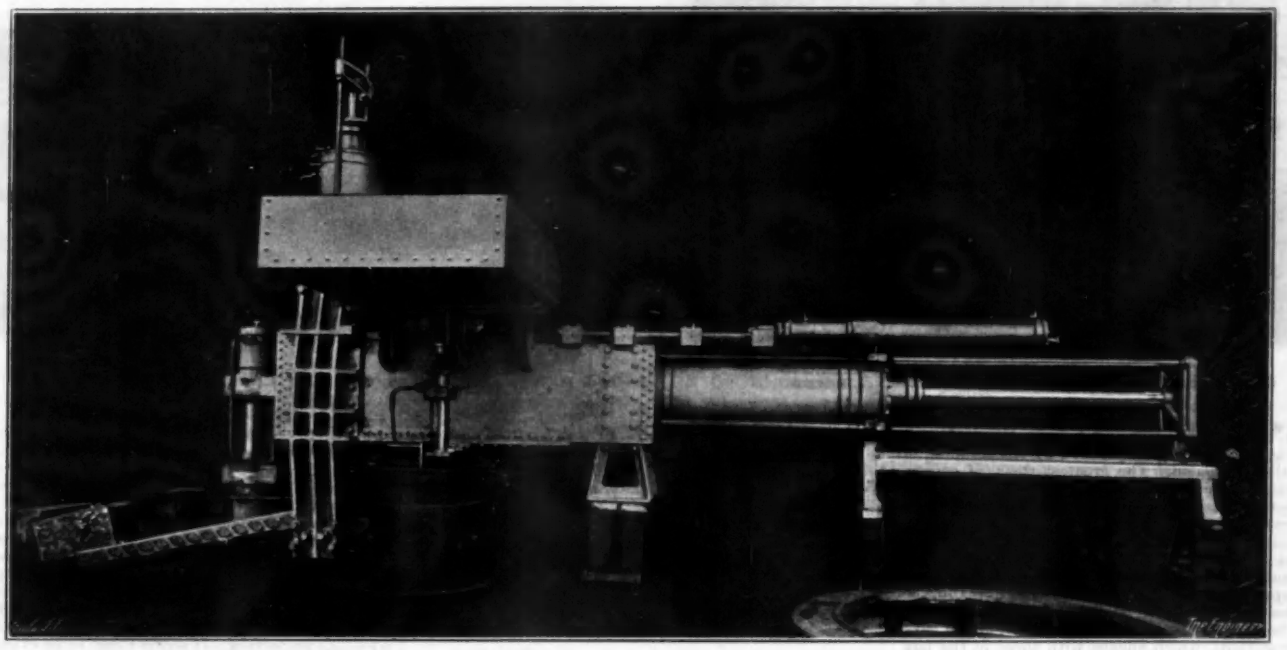
Total Weight 20 tons.

Water Used per Complete Cycle for 1 Bale Without Intensifier - 63 Gallons

A LARGE HYDRAULIC SCRAP BALING PRESS

ROSE, DOWNS AND THOMPSON, LTD., HULL, ENGINEERS

GENERAL VIEW OF THE EQUIPMENT



SIDE VIEW OF THE BALING PRESS

A Large Scrap Baling Press.

A PRESS for baling scrap metal, which is of unusual interest, not only on account of its size, but also because it has been exported from this country to the Continent, in open competition, has just been finished by Rose, Downs, and Thompson, Ltd., of Hull. Of it we give some photographic engravings herewith, and a line drawing which shows its general arrangement.

This press will be used for baling all classes of light iron and steel scrap, shearings, clippings, sheet iron, &c., up to about ¼in. thick, as well as enamelled iron and tin-plate scrap, galvanised iron, &c. The bales produced will, it is believed, be readily and profitably disposed of to steel works and blast-furnaces, where the unbaled scrap would not be accepted.

The output of the press is from 10 to 18 tons per hour, depending upon the class of material being baled, the individual bales weighing up to 6 cwt. each. Everything has been arranged to allow of rapid working, and all motions are hydraulically operated, so that an output of over sixty bales an hour will easily be obtained.

The machine comprises two main features, a horizontal box, into which the loose material is tipped, and wherein it is roughly compacted, and a vertical press for finishing the bale under a much higher pressure. The bales produced in this way bind together quite naturally and do not need any banding. In fact, we have knocked about, quite vigorously, a bale made of turnery swarf, and found that it scarcely shed any of its material. With larger scrap the bale is, naturally, even more rigid.

The loose material is tipped into the box from an hydraulically operated charging hopper, which holds sufficient material to fill it. When the box is filled, its top is closed by a sliding door worked by a hydraulic cylinder. The door is of steel plate heavily reinforced with steel sections. Pressure is then admitted into a horizontal or "condensing" cylinder of the press, the ram of which presses the loose material in the box into a consolidated mass at the opposite end, underneath the vertical or main cylinder. This portion of the box is built up of heavy ribbed cast steel side frames, which are extended upwards to carry the inverted vertical main cylinder. When pressure is then applied to this cylinder, it causes the bale to be compacted in a direction at right angles to the former compression, and thus thoroughly interlocks the constituent pieces of scrap, making a solid and homogeneous bale, which will stand any reasonable treatment during handling and transportation. Normal pressure is first applied to the main cylinder, and, if desired, is followed by a higher pressure supplied by an intensifier.

The bale is now made and is ready to be discharged from the press. This is done by drawing back the sliding bottom

of the box, leaving an opening through which the bale is ejected by the further descent of the main ram. The next motion of bringing forward the sliding bottom to close the lower opening of the box pushes the bale on to a roller runway in front of the machine.

In this case the runway is arranged with non-magnetic rollers, so that the bale can be picked up by means of a magnetic crane and loaded straight into railway trucks or stored for subsequent despatch.

All the motions of the press are controlled by lever-operated balanced piston valves grouped together on a control platform on the side of the press in such a position that the man in charge can see exactly what is taking place at all points.

The scrap is dumped into the charging hopper by means of an overhead crane magnet, so that very little labour is required to handle large quantities of scrap.

There are some interesting and novel features in the design of this press, which is constructed entirely of steel. The cylinders, box ends, and sliding bottom, and the larger rams are of cast steel. The smaller rams are of forged steel.

The stroke of all the rams is determined by positive stops in the cylinders, thus preventing any possibility of over-running and consequent damage to the cylinder. Hence, the operation of the press is foolproof, no matter in what way or sequence the valves are opened. The stroke of the condensing or horizontal ram is adjustable against stops within limits.

The press box is built up of rolled steel plates, and is fitted with detachable reversible lining plates of high carbon steel, to resist the wear caused by the scraping of the material being baled. The greatest wear, of course, takes place towards the end of the box and the lining plates are, therefore, so made that they can be changed round end for end when wear does take place.

To prevent the formation of "flash," *i.e.*, projecting pieces of flat metal round the edges of the bale, the carbon steel side and bottom lining plates are machined all over with V-shaped corrugations running longitudinally, as shown in the end view of the box. The sides and bottom of the ram head of the condensing ram are machined with similar corrugations, which engage with those in the box liners. This makes it impossible for flat pieces of scrap to get at the side or bottom of the bale, as they will be crumpled up by the corrugations, and also prevents any tendency for the ram head to lift slightly should it encounter a piece of flat metal laid against the bottom or side of the box and slide over it.

The method employed for fixing the grooved lining plates does away with the necessity of having countersunk bolts inside, the heads of which are likely to cause wear to start in patches.

The cast steel cylinders are all fitted with gun-metal neck rings and gun-metal-lined glands, and all packings are easily accessible without any dismantling being required. The bearings in all the cylinders are internally ground and the rams are externally ground, which has been proved to effect great reduction in wear and tear of hydraulic packings.

The drawback cylinders, door-operating cylinder, charger cylinder, and discharge table-operating cylinder are under constant pressure, and are thus simply operated by opening to exhaust. The drawback cylinders are designed for rapid operation, so that no time is wasted between bales.

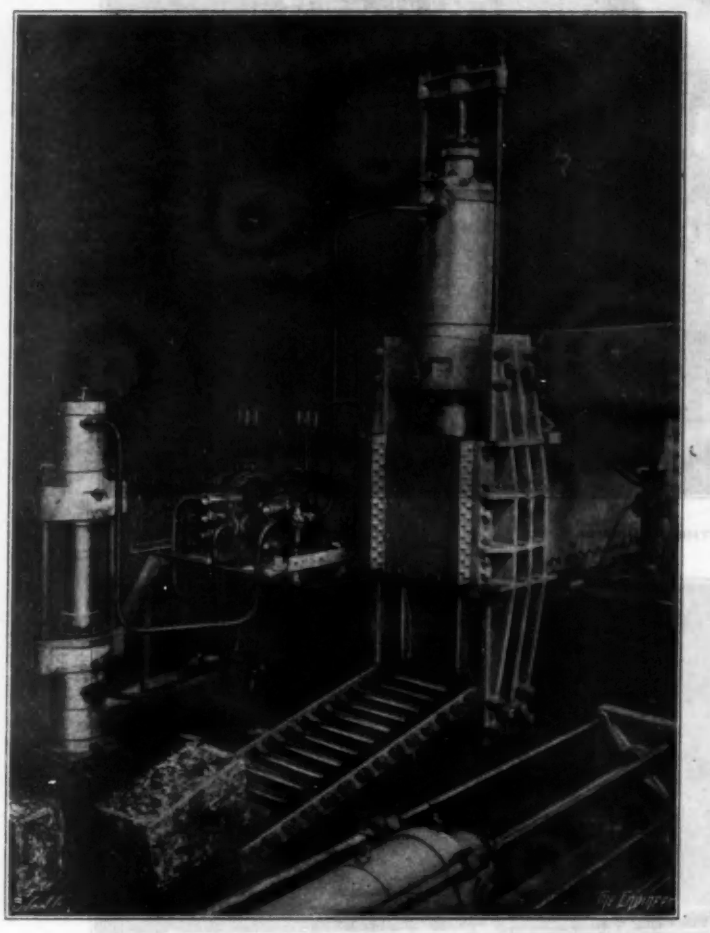
All the pipes are of large bore to allow of rapid filling and emptying of the cylinders. Gun-metal air and drain cocks are fitted to all the cylinders.

The operating valves are of the balanced piston type, the bodies, of hydraulic gun-metal, having specially designed frictionless ports. The barrels are ground internally. The valve spindles are made of "Nitralloy" steel, machined to within grinding limits and then heat-treated or "Nitrided." The spindles are then ground to suit the valve bodies. The packings used in the valves are oak-tanned leathers, the "U" leathers being fitted with gun-metal spacing rings.

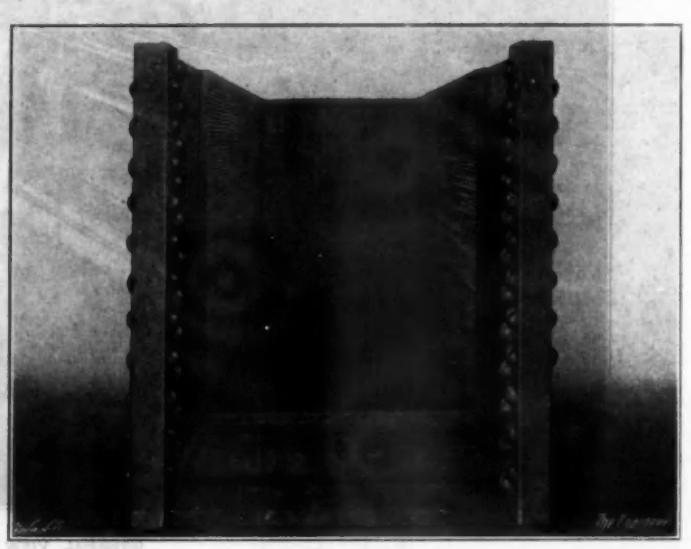
The positions for the operating levers are registered by spring-loaded ratchet stops engaging in steel quadrants. The levers themselves are forged solid with the rocking levers, which engage in machined slots in the spindles. This arrangement prevents any back lash developing through wear, which would cause the stroke of the valve, and consequently the port opening, to be reduced. A feature of these valves is the ease of operation which results from the exact balance of the spindle. The various positions corresponding to given movements of the press are marked with engraved labels on the quadrants.

The whole press is designed to work at 1800 lb. per square inch, but as arranged it will normally work at 1150 lb., with an intensifier to give a pressure of 1800 lb. on the main cylinder, should it be required for any particular material being baled. The intensifier is designed to give a reduction of depth in the bale of 5in. If desired, the press can be worked throughout from an accumulator at either of the above pressures, or two accumulators can be used for high and low pressure. The intensifier, however, makes a very compact and neat arrangement, and is suitable for dealing with materials generally met with in scrap yards.

Some of the leading dimensions of the press are given on the drawing.



DISCHARGE END AND CONTROLS OF BALING PRESS



PRESS BOX

PRESS BOX AND CHARGING HOPPER

French Import Quotas.

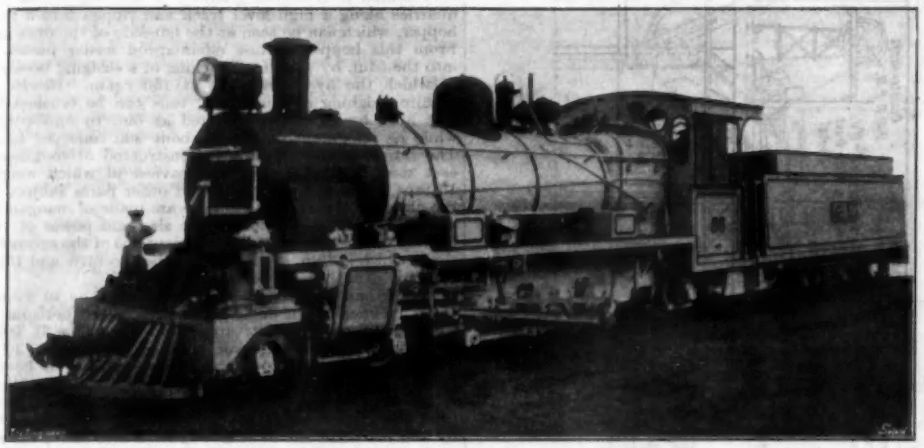
WHEN the French Government initiated the import quota system it was regarded as an experiment in dealing with an entirely new situation, arising out of the change in economic conditions. It could not be met solely by the existing fiscal tariffs. At a time when works are closing down and unemployment is increasing, the rapidly growing imports of manufactured goods from countries that have facilities for cheap production or are prepared to export surplus products at almost any price, complicates a dangerous situation. With so many countries off the gold standard, tariffs on imports into a country which keeps to gold lose much of their efficiency as a protection for home industries. The super-tax is an unsatisfactory remedy because it introduces an element of discrimination which is regarded by countries affected by it as contrary to the spirit of existing commercial treaties, and its essentially variable character, moreover, renders it impossible for those countries to make provision for future business. Therefore the French Government is extending import quotas which are allocated to different countries according to the quantities of goods they have exported to France during a stated period. This was done in the case of hot rolled sheets, and then of wireless sets, valves and accessories. Now the electrical engineering industry is being protected in the same way. On the ground that French electrical engineering works have experienced a reduction of from 30 to 75 per cent. in the volume of trade, as compared with that during 1930, and that they are now running less than 40 hours a week, French manufacturers have been carrying on negotiations with the German Central Association of the Electrical Engineering Industry in order to fix upon quotas, and these having been agreed upon, the Government has enforced them by decree until the end of March next. The maximum quantity of dynamos, transformers, and electrical equipments for motor cars to be imported during that period is 517 metric tons, of which Germany will supply 224 tons, Switzerland 118 tons, Great Britain 40 tons, Sweden 39 tons, and the United States 37 tons. The imports of switchgears are limited to 152 tons of non-automatic and 111 tons of automatic apparatus, Germany supplying respectively 100 tons and 30 tons, Great Britain 15 tons and 27½ tons, and Switzerland 14½ tons of each category of switchgear. The imports of electric heating apparatus will not exceed 64½ tons, Germany supplying 37 tons and Switzerland 10 tons. Further negotiations are now being carried out by the Confédération Générale de la Production Française and the German Iron and Steel Makers' Federation with a view to fixing upon quotas of iron and steel imports into France. The idea of the French Government is to allow French manufacturers to settle the quotas with their chief competitors in a way to ensure reciprocity, so that the exchanges will not be detrimental to the industries of the countries concerned. On the other hand, it is obvious that as the distribution of quotas is based upon arrangements with a country which exports most of particular classes of goods to France, it is possible that unfair treatment will be meted out to other countries which, for temporary causes, have not exported to France anything like the same quantities. It is too early yet to say how far the import quota system will prove satisfactory to everyone concerned, but, for the moment, it is certainly acceptable to French manufacturers, who regard it as the only means of securing adequate protection. It seems likely to be extended to all classes of manufactured goods, and may become a permanent factor in the French trade policy.

Two-Foot Gauge Locomotive for India.

THE illustration on page 165 shows a locomotive which is remarkable in view of the very narrow gauge, only 2ft., for which it was designed. It has cylinders 11in. by 18in., can develop a tractive effort of 10,100 lb., and weighs with its tender, in working order, over 47 tons.

The engine is one of eight constructed by W. G. Bagnall, Ltd., of Stafford, under the inspection of Messrs. Robert White and Partners, of London, for the Gwalior Light Railways, four of them being destined for use on an extension of the line known as the Ujjain Agar Railway. The six-coupled driving wheels are 2ft. 9in. diameter and the load on each axle is 6 tons. The bogie wheels are 1ft. 8in.

in diameter and the trailing wheels, 2ft. in diameter, are fitted with Cortozzi axle-boxes. The boiler is exceptionally large for the gauge. The evaporative surface is 592ft., of which 62 square feet are in the fire-box, and there is a superheater of 130 square feet. The grate area is 12·3 square feet. The length between the tube plates is 11ft. 3in. and the working pressure 180 lb. The fitting seen immediately behind the dome is a "Filtrator." It consists of a cast iron receptacle surrounded by fins. Inside this receptacle is placed a steel container holding linseed. Steam is allowed to enter and in condensing abstracts starches from the seeds in colloidal form, and then re-



LOCOMOTIVE FOR GWALIOR LIGHT RAILWAY

enters the boiler where the starch collects round the scale particles and prevents a hard deposit from forming. The headlight is of the Sunbeam electric pattern.

The tender carries 1500 gallons of water and 4 tons of fuel, and the total length, engine and tender, over buffers is 40ft. 3½in., and the maximum height 9ft. 6in.

Although the Gwalior Railway has already engines of a similar type, these are the most completely modern in its possession. The total mileage of the line is about 250; there are gradients of 1 in 80, and curves as sharp as 250ft. radius. We understand that these locomotives were tested over a radius of 200ft. before leaving England.

Portable Oil-Testing Sets.

A LARGE number of portable oil testing sets, similar to that shown in the accompanying illustration, are in course of manufacture at the British Thomson-Houston Company's Rugby works. The equipment has been designed to meet the demand for a small and compact oil-testing set for making periodical tests on samples of transformer and switch oils drawn from plant in service, and also for checking the electric strength of new oil. To ensure satisfactory results it is necessary for an oil-testing set to have sufficient power to produce complete breakdown of the oil sample under test, and the transformer included in the B.T.H.

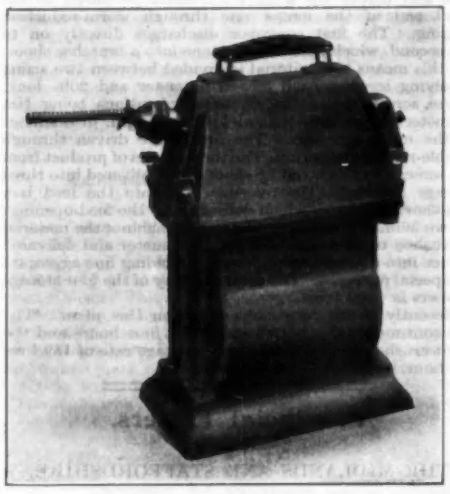


FIG. 1—PORTABLE TRANSFORMER—OIL TESTER

equipment has been designed to provide the power required, thus making it superior to oil-testing sets depending on an accumulator and induction coil for its source of supply. There are no delicate instruments likely to be damaged or working parts liable to get out of order. The complete set may be easily carried about by means of the handle provided, the total weight being just over 50 lb. As shown in the illustrations, the equipment consists of two main portions. The top portion or hood acts as a cover for the oil-testing cup when the set is being transported, and is bolted to the tank by means of hinged bolts and wing nuts. The incoming supply is brought into the set by means of a three-core C.T.S. cable and is connected through the cover by means of a fully shrouded detachable three-pin plug. From this plug the supply is taken through a two-pole spring loaded ironclad switch mounted on the opposite end of the cover, and thence through a length of inter-connecting cable to the primary winding of the transformer. The spring-loaded switch is provided with a damping resistance to limit the current flowing at the moment of make or break, thus preventing voltage surges which might seriously upset the readings.

When the equipment is in use the top is removed from the transformer tank and placed on the ground a safe distance away, the two portions being permanently connected together by means of a three-core cable, as shown in Fig. 2, the third core being connected solidly to earth at the incoming end, and used for bonding together all metal portions of the cover and transformer tank which do not carry current. The arrangement ensures absolute safety in operation, as all parts of the apparatus which may come into contact with the operator are at earth potential. The lower portion of the equipment consists of a tank containing the transformer, which is immersed in soft insulating compound, whilst the top of the tank is covered by a board made of insulating material on which the primary terminals of the transformer, the H.V. bushings and the voltage selector connected to the primary tappings on the transformer are mounted. The oil-testing cup, which is of

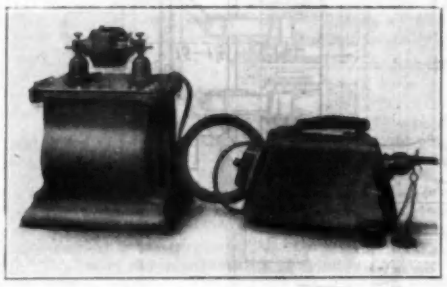


FIG. 2—SET AS ARRANGED FOR TEST

neat design and contains the H.T. electrodes, is mounted between the H.V. bushings. To complete the earthing of the equipment the core and the mid-point of the H.V. winding are both solidly connected to the tank. When the set is not in use the cable connecting the cover and the transformer is coiled up inside the cover.

MANCHESTER ASSOCIATION OF ENGINEERS.

ON Friday, January 22nd, Mr. G. R. Adamson, M.I. Mech. E., read a paper before the Manchester Association of Engineers entitled "The Waste Heat Boiler and its Effects on Furnace Design, Operation and Output." He said that the temperature of the waste gases from an open-hearth furnace was such that, when passing through a boiler, their power of transmitting heat by radiation was almost negligible, so that a waste heat boiler to be successful must be designed as a connective heat exchanger. When comparing a waste heat boiler with a fuel-fired boiler, it was necessary to remember that the gases presented to the first-named had usually only about 30 per cent. of the available heat in them as compared with the second. The waste heat boiler must therefore deal with three to four times the volume of gas handled by a fuel-fired boiler for the same evaporation. High gas velocities were therefore imperative in a waste heat boiler attached to a furnace having a large fuel consumption if a boiler of reasonable dimensions was to be used. Of the two types of waste heat boiler in use the fire-tube type was usually better than the water-tube type. A typical fire-tube waste heat boiler installation consisted of a cylindrical flat-ended shell traversed from end to end in the water space by a number of small bore tubes. At each end there were boxes, that at the inlet end being lined with refractory and insulating material and, in most cases, housing a superheater. The suction opening to the fan was connected to the outlet or fan box, which usually had large hinged doors to give access to the tubes. The fan discharged to the atmosphere by way of the existing furnace stack, or, in cases where that was not convenient, to a special short steel stack. In an open-hearth furnace the speed of operation was governed largely by the speed of melting which, in turn, was dependent upon the rate at which heat could be transmitted from the burning gases to the metal in the bath, the latter depending upon the flame temperature realised and the velocity with which the hot burning gases were presented to the cold charge. A waste heat boiler, according to Mr. Adamson, would reduce the stack gas temperature from 550 deg. to 240 deg. Cent., and it followed that about 58 per cent. of the heat in the waste gases was recovered as steam, while the overall efficiency of the furnace was increased by at least 17 per cent.

Books of Reference.

"*The Motor Ship*" *Reference Book*, 1932. London: The Temple Press, Ltd., 5–15, Rosebery-avenue, E.C. 1. Price 5s. net.—The text for the eighth annual edition of this valuable book of reference has been carefully revised and all the statistics relating to motor ships and motor shipping have been brought up to date. It is interesting to note that, notwithstanding the depressed state of the shipbuilding industry, a number of important developments in the propelling and auxiliary machinery took place during the year, and are dealt with in some detail. One of the most interesting and valuable tables in the book has always been that covering motor ships of over 2000 tons in service in the world. A new supplementary list shows that no less than 176 motor vessels were completed in 1931 and that at present over 100 are on order. The section on main propelling engines is on the same lines as in previous issues, each maker's engine is dealt with separately, and in nearly all cases a drawing and photograph enhance the value of the description. We note that all the most recent engine types are included. An important section is that relating to the auxiliary engines, and in it all the latest British and Continental types are fully dealt with. We have no doubt that the new edition of this book will be found as useful as its predecessors.

The Ice and Cold Storage Trades Directory for 1932. London: Iliffe and Sons, Ltd., Dorset House, Tudor-street, E.C. 4. Price 11s. net.—This is the only English directory of the refrigerating industry, the steady progress of which is indicated by the fact that some twenty-five new companies have been registered during the past year. It follows the lines of previous editions, opening with Tables of Temperature, Properties and Capacities, followed by details of new companies, particulars of the British Association of Refrigeration, Imported Meat Trade Association, National Federation of Cold Storage and Ice Trades, Institut International du Froid, lists of Cold Stores and Ice Factories, and a Classified Trade Section of Great Britain and Ireland.

The Concrete Year Book, 1932. Edited by Oscar Faber, O.B.E., D.Sc., and H. L. Childe. London: Concrete Publications, Ltd., 20, Dartmouth-street, S.W. 1. Price 3s. 6d. net.—A very interesting new feature in this book is a chapter giving illustrations and particulars of over a hundred reinforced concrete structures completed or under construction during 1931. These particulars cover practically every branch of the industry, including buildings, bridges, roads, foundations, wharves, &c. The data and bibliography given in the book have been thoroughly revised and brought up to date. The volume should be of value to all connected with the varied industries in which concrete is employed.

The "Practical Engineer" Mechanical Pocket Book and Diary, 1932. Edited by E. G. Beck. London: Oxford University Press, Amen House, Warwick-square, E.C. 4. Price 2s. 6d. net.—For its forty-fourth edition, this book has been entirely reset, and all notes, tables, data, &c., have been thoroughly revised. Several sections, including those on Steam Engines, Turbines, Gas and Oil Engines, have been rewritten, whilst a new section on Locomotive Practice and Notes on Marine Boilers have been introduced. This little volume has always been of great use to mechanical engineers, and the addition of some hundred pages has enhanced its value to no small extent.

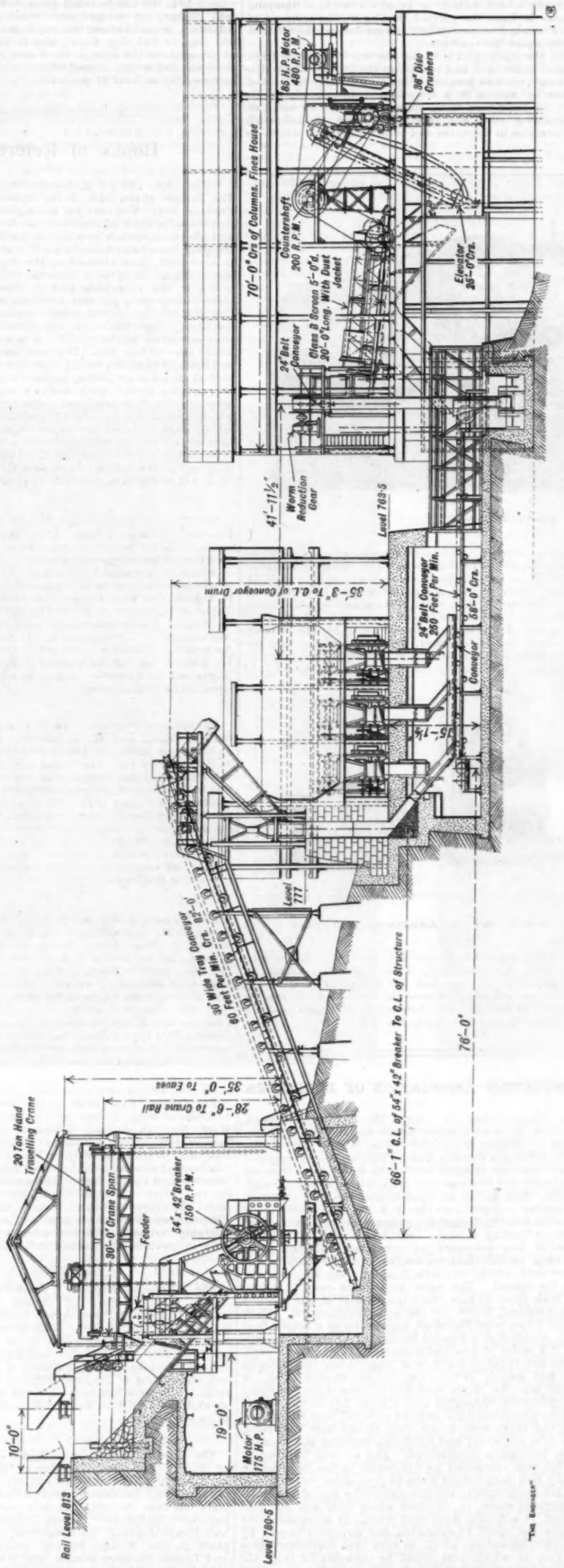
The Official Year Book of the Scientific and Learned Societies of Great Britain and Ireland: A Record of the Work Done in Science, Literature and Art during the Session 1930–1931. London: Charles Griffin and Co., Ltd., 42, Drury-lane, W.C. 2. Price 10s. net.—Users of this book of reference will recollect that last year the publishers stated that in future editions the practice of printing the "List of Papers Read" for each Society would cease. The forty-eighth edition, by this omission, is some 200 pages smaller, and the price of the book has been considerably reduced. All the other valuable information given in previous editions has been retained and revised.

The "Practical Engineer" Electrical Pocket Book and Diary, 1932. Edited by Conrad Arnold. London: Oxford University Press, Amen House, Warwick-square, E.C. 4. Price 2s. 6d. net.—This little reference book has been familiar for many years to all connected with the practical side of electrical engineering, and the new volume provides a clear summary of the main principles and an account of modern electrical methods and apparatus. The book has been carefully revised and brought up to date by experts, and it will be found quite as useful as its predecessors.

The Practical Electrician's Pocket Book, 1932. Edited by F. H. Robinson. London: Odhams Press, Ltd., 93, Long Acre, W.C. 2. Price 2s. 6d. net.—Following the usual practice the thirty-fourth edition of this little pocket book has been revised, and this year two new sections have been included—"Picture Telegraphy" and "Power and Power Factor." A considerable revision has taken place in the Marine Section, Portable Electric Tools and Textile Industry section, and it is evident that many other parts of the book have received careful attention.

PLANT FOR THE PRODUCTION OF CONCRETE AGGREGATE FOR THE CAUVERY METUR DAM

HADFIELDS, LTD., LONDON AND SHEFFIELD, ENGINEERS



Concrete Plant for the Cauvery Metur Dam.

IN the Madras Presidency work is in progress on the construction of the Cauvery Metur Dam, which, when completed, will allow one of the largest water reservoirs in the world to be filled. In connection with the work Hadfields Ltd. have supplied plant for the production of concrete aggregate, and illustrations on page 158 and the drawing illustrate the lay-out of one of three similar units now at work.

The material being crushed is Charnockite, a hard stone very similar to Aberdeen granite. It is brought from the quarries along a high level track and tipped into a feed hopper, which can be seen at the left side of the drawing. From this hopper a Ross chain-apron feeder passes it into the 54in. by 42in. feed-opening of a sledging breaker, of which the fly-wheel turns at 150 r.p.m. Blocks of granite weighing as much as 2 tons can be crushed by this huge breaker, and delivered as 6in. to 8in. cubes, while its maximum output is about 200 tons per hour. The frame of the machine is constructed of toughened cast steel in four pieces, the heaviest of which weighs 15 tons, while the jaw plates and other parts subject to the abrasive action of the granite are made of manganese steel. A good impression of the size and power of the breaker can be gained from the dimensions of the excentric shaft, which is 19in. in diameter at the excentric and 16in. in diameter at the side bearings.

The sledging breaker delivers the granite on to a conveyor inclined at an angle of 20 deg. to the horizontal, working on centres 82ft. apart and travelling at 60ft. per minute. This conveyor is fitted with trays 30in. wide and 8in. deep, attached to two strands of heavy bushed chain. The upgoing chains are supported on rollers spaced at intervals of 4ft. and are driven by a 15 H.P. motor through worm reduction gearing. The material is delivered by the conveyor on to a grizzly or bar screen, having spaces tapering from 2½in. at the point of entry to 3in. in width at the outlet. In order to withstand the heavy wear the bars of the grizzly are made as castings of manganese steel. Most of the material, of course, passes over the grizzly, but a certain proportion drops through and is led by a shoot directly to the fines conveyor. The oversize remainder is delivered into a large storage bin and fed thence by Ross chain feeders to a battery of six jaw crushers having feed-openings 24in. by 13in. These crushers are arranged in two groups of three machines each, one group on one side of the storage bin and the other on the other side. Each group of three is driven by a 120 H.P. electric motor. Since, in addition, the chain feeder to each machine is driven through a clutch, the arrangement is such that the feed to any one or more machines may be cut off, or the three crushers in one group may be cut out together by stopping the driving motor. Flexibility is thus provided for varying loads. The breakers at this part of the plant have frames, jaw-stocks and pitmen constructed of toughened cast steel, and jaw-plates, cheeks and toggles of manganese steel. They reduce the granite material from 6in. cubes down approximately to 2½in. cubes and deliver it on to the fines conveyor, on to which the fines coming from the sledging breaker have already been by-passed by the grizzly.

The remainder of the plant is offset from the centre line of that so far described by about 150ft. It was therefore found necessary to convey the material to the later stages by two belt conveyors. The first of these transporters is 24in. wide and runs on 58ft. centres, measured horizontally. The second has the same width as the first, runs on 157ft. centres at an inclination of about 18 deg., and travels in a direction at right angles to that of the first. The two conveyors are coupled together by chain and bevel gearing at the tail end of the inclined belt and driven by a 22 H.P. motor mounted at the head end of the longer one through worm-reduction gearing. The first conveyor discharges directly on to the second, which delivers the stone into a breeches shoot. By this means the material is divided between two sizing revolving screens, each 5ft. in diameter and 20ft. long. These screens are jacketed, the perforations being ⅝in. diameter in the jackets, and 1½in. and 2½in. in diameter in the main cylinders. The drums are driven through double-reduction gearing. The three grades of product from the screens are collected by shoots and delivered into three storage hoppers. The oversize falls into the feed box of a short conveyor, which delivers it to the feed-openings of two 36in. disc crushers. In these machines the material is crushed to approximately 1½in. diameter and delivered thence into a fourth storage hopper holding fine aggregate for special purposes. The total capacity of the four storage hoppers is 1700 tons.

Recently a test was carried out on this plant. The run continued for a period exceeding four hours and the plant crushed the material at the average rate of 189 tons per hour.

Provincial Letters.

THE MIDLANDS AND STAFFORDSHIRE.

(From our own Correspondent.)

Tariffs Encourage Hope.

ALTHOUGH manufacturing interests in the Midlands and Staffordshire do not consider Mr. Chamberlain's proposals entirely satisfactory, in that they do not come up to what they deem necessary for the rejuvenation of trade, they are nevertheless looked upon as acceptable as a start, as being a step towards prosperity and as holding out considerable hope for the future. Industrialists recognise that an attempt is being made by the Government of the country to offer manufacturers a fair chance in their own markets, some security against foreign dumping, a key whereby entrance into foreign markets can be obtained and a basis for extended colonial preference. The present tariff is recognised to be only a beginning, and iron and steel manufacturers especially will no doubt as early as possible bring what pressure they can to bear upon the powers that be to persuade them to take more decisive action in favour of this particular

industry. Under the influence of the new anticipations the tone of the Birmingham iron market, which had been falling during recent weeks, improved again to-day—Thursday. Conversations were carried out in a brighter vein. It is confidently expected that in the near future there will be a greater demand for local material and for Midland manufactures, and a close watch is being kept on the market. It is quite within the bounds of possibility that there will be some rise in prices of raw and semi-finished material and of manufactures, and successful anticipation of market movement in the near future may well lead to better profit. There was no marked increase in demand in any branch this week; indeed it was far too early to expect any such thing as a result of the national change of front, while there has been no betterment of activity at the works in this area over the week to justify expectations of better buying on account of present consumptive requirements. The heavy industries in this district are uniformly dull, though the improvement recently noted in the heavy edge tool trade is maintained. Progress is slowly being made in the lighter trades, and there is a little more movement in the automobile engineering industry, especially in the Coventry area. There is little change in the general level of iron and steel prices.

Raw Iron.

After reviewing the trade position at its usual monthly meeting, the Central Pig Iron Producers' Association decided to make no change in the current prices. It was not thought by consumers as at all likely that there would be any advance in selling rates and no provision had been made against such a contingency. The check to activity in the light foundries continues, and specifications are becoming increasingly scarce. Blast-furnacemen are adding to their stocks, not being able to dispose of the whole of their present output, particularly in the Northamptonshire area, where furnacemen are not associated with pipe foundries to the same extent as their brethren in Derbyshire. The heavy foundries and the forges in this area show no signs of becoming better customers in the near future. The general position is not so bad in the raw iron industry, however, as it is in some others, and for that furnacemen are thankful. The scale of minimum selling prices now in force is as follows:—Northamptonshire forge, £2 17s. 6d.; No. 1 foundry, £3 5s. 6d.; No. 2, £3 4s. 6d.; No. 3, £3 2s. 6d.; No. 4, £3 1s. 6d.; Derbyshire forge, £3 1s.; No. 1 foundry, £3 9s.; No. 2, £3 8s.; No. 3, £3 6s.; No. 4, £3 5s., delivered at stations in the Black Country and subject to rebate.

Steel.

The steel market is dull, conditions having been rendered worse during the past week by the uncertain position regarding tariffs. Now that something definite is known, perhaps business will begin to move again. The trouble, at any rate as far as the finished branch is concerned, is the lack of consumptive requirements. Constructional engineers in this area almost without exception complain of the flatness of trade. They are hard hit by the cessation which has fallen on the many important rebuilding schemes that were carried out on city sites, in which steel frames and reinforced concrete construction figured largely. Mills rolling structural steel are precariously placed. They have contracts on the books, but few specifications. Plant stands or is set in motion as orders fail or materialise. Values controlled by the Steelmasters' Association are rigidly adhered to. Angles are £8 7s. 6d., tees £9 7s. 6d., joists £8 15s., ship, bridge and tank plates £8 17s. 6d., all per ton less their respective rebates to buyers confining themselves to British material. Boiler plates sell at £8 12s. 6d. Business has been temporarily suspended in the half-products department this week. Producers have been awaiting the Government's pronouncement before committing themselves further. They continue to quote recent selling rates. Small steel bars re-rolled from Continental billets are £6 12s. 6d. upwards, and all British bars £7 5s. Mild steel billets are quoted £5 7s. 6d. to £5 10s., and sheet bars £5 5s. Ample supplies of Continental material are available in works and warehouses in this country, but no new orders are being given out.

Manufactured Iron.

Business remains flat in the Staffordshire finished iron trade, orders being scarce and of small dimensions. Mills are only working on a hand-to-mouth basis, producers not being able to see more than a week ahead. Unfortunately they do not view the immediate future with optimism. There are no signs, to say nothing of tangible evidences, of an awakening demand for finished iron, and the first quarter of the year is likely to be a very poor one for ironmasters in this area. Selling prices are unchanged. Marked bars are £12 at makers' works, Crown quality £9 5s. upwards, bolt and nut and fencing bars £8 7s. 6d., and wrought iron gas tube strip £10 10s. to £10 12s. 6d. per ton delivered.

Galvanised Sheets.

Demand for galvanised sheets continues to expand and values have hardened further. Some millowners having secured fairly good orders at the enhanced selling rates of £9 5s. to £9 7s. 6d., mentioned last week, are now quoting £9 10s. per ton f.o.b. for galvanised corrugated sheets of 24-gauge. Consumers are hesitating to pay this new price and mills, which are not well placed, are accepting good tonnage orders at a figure somewhere in the regions of £9 5s. to £9 7s. 6d. Competition remains keen and makers find it difficult to raise selling prices and maintain them at a higher level. There is no change in other branches of the sheet trade, neither in volume of demand nor in quotations.

Re-rollers and Foreign Steel.

The Midland Steel Bar and Strip Re-rollers' Association has issued for publication a report that deserves wide publicity. It not only serves as a reminder of the complications in the iron and steel industry, but it also offers evidence that any effective policy of protection must inevitably cover that industry. The Association declares that unrestricted importation of Continental steel has definitely been against the interests of the re-rollers, and the development of foreign competition in the finished material will eventually force every user of Continental steel to ask for some definite restriction in the import of that material. After analysing the situation, the statement summarises the conclusions of the Association as follows:—Unrestricted importation of foreign steel is most strongly condemned as being injurious to the interests of the re-rolling industry. Foreign competition is most unfair by reason of the disproportionate prices of raw and finished classes of steel. It is our firm conviction that the foreigner is working to secure our finished trades, thereby securing employment consequent upon the production of raw semi-finished material as well as the finished goods. The statement that the present importation of foreign steel is necessary for the maintenance of the export trade is a bogey which can be exposed by definite records. Devaluation is only a very slight protection to the steel trade and is, of course, of a very precarious nature. Members of the Midland Steel Bar and Strip Re-rollers' Association unanimously ask the Government to take immediate action drastically to restrict the importation of foreign steel.

Training Young Engineers.

Proposals for obtaining closer co-operation between the Education Committee and the Engineering Employers' Association in the training of apprentices for the engineering industry in the city are under consideration. A memorandum by the Principal of the Central Technical College with reference to the establishment of a scheme of part-time and full-time courses for the engineering industry in the city suggests insufficiently close co-operation between the engineering employers and the Education Authority. As a result, the courses of study organised at the technical colleges tended to become isolated from the works apprenticeship, instead of being an integral part of it. It is suggested that the Engineering Employers' Association should be asked to co-operate in an apprenticeship scheme which would lead to the award of a Birmingham Engineering Apprenticeship Certificate—to be endorsed jointly by the Education Authority and the Engineering Employers' Association—to all apprentices who complete a works training, together with suitable courses of technical instruction, and whose record of both training and education at the age of twenty-one is satisfactory. The Association is in agreement with the proposals, and a committee has been established to prepare rules and procedure. It is suggested that Mr. G. E. Nineas, the Assistant Secretary of the Engineering Employers' Association, should act as secretary of this committee, and that he should keep personally in touch with the Principal of the Central Technical College on all matters connected with the operation of the scheme. The word "apprentice" is meant to include all who have had a systematic works training, whether formally indentured or not.

Big Waterworks Scheme.

South Staffordshire Waterworks Company has approved a Bill to be introduced into Parliament to secure authority to construct new works, raise additional capital, to extend the limits of supply and for other purposes. The scheme outlined provides for the construction of a new well and power station between Tamworth and Ashby-de-la-Zouch, various trunk mains, new or duplications of existing reservoirs—one at Langley and one near Dudley—and the incorporation of some new districts into the area of supply. The amount of additional capital to be sought is £500,000.

New Sewage Works for Warwick.

Warwick Town Council have decided to proceed with a scheme for the construction of new sewage works at an estimated cost of £34,685. The Unemployment Grants Committee having declined to make any grant, the cost of the works will fall upon the local rates.

Colliery Development.

The board of directors of the Staveley Coal and Iron Company has decided, as part of a progressive scheme for the modernising of their collieries, to open out immediately a deep hard seam at Markham No. 4 Colliery, Derbyshire, and to remodel entirely the surface arrangement at the adjacent Ireland Colliery. A recent arbitration awarded the company an additional quarter of a million tons of coal.

Birmingham Electricity.

The growth of the Birmingham Electric Supply Department, which now has more than 116,000 consumers, has resulted in the City Council being recommended to spend £719,941 on extensions. It is proposed to allocate £500,000 to general mains extensions and £200,000 to sub-station buildings and plant. New customers connected during the past twelve months numbered 24,000, and the sales of electrical energy during December quarter were up by 12 per cent. on the quantity sold during the corresponding period of 1930. The improvement is said to be represented, in the main, by a fuller electrification of consumers' works rather than as indicating improved industrial conditions. The total sales for the quarter amounted to 108¼ million units, being an increase of 11¼ million units over December, 1930.

Constructional Engineer's Retirement.

On the occasion of his retirement from the service of the Birmingham City Corporation, Mr. L. S. Carr—constructional engineer to the Electric Supply Department—was the recipient of some pieces of silver, subscribed for by the staff of the department as a token of their goodwill and esteem. In making the presentation, Mr. F. Forrest—City Electrical Engineer—indicated Mr. Carr's prominent responsibility in connection with the large plant extensions which had been made during the past twenty years. Mr. Carr also received from the Electric Supply Committee an illuminated engrossment on vellum of a minute appreciating his services, and Mrs. Carr was presented with an antique silver cream jug.

LANCASHIRE.

(From our own Correspondents.)

MANCHESTER.

The New Road Conditions.

FOURTEEN years ago, on the proposals of the Traffic Congestion (Special) Committee of the Corporation, the Manchester City Council sanctioned the construction of a number of extensive new routes, of which up to the present only one, at a cost of £292,000, has been completed. The Transport Committee of the Corporation has now adopted a report prepared by Mr. R. Stuart Pilcher, the general manager of the Transport Department, and the Committee's recommendation that it should be relieved of all financial obligation as regards the proposed new roads is being considered by the Council this week. Mr. Pilcher emphasises in his report that since the proposals of the Traffic Congestion Committee were adopted in 1917 a development has taken place in the mode of passenger transport in the city which was not contemplated at the time the programme of construction was prepared. Within the last eighteen months the Transport Department has abandoned tramway routes which represented 14 per cent. of the entire tramway system. If motor omnibuses are to be used on the new roads instead of tramcars, states Mr. Pilcher, the traffic will be dispersed through several streets in the immediate vicinity, and he suggests that the Transport Committee should not share the responsibility or contribute to the cost of any widening or improvement of the routes that may be considered desirable.

From Tramcars to Motor Omnibuses.

An indication of the extent of the change-over from tramcars to motor omnibuses that is going on is furnished by the estimates of the Manchester Corporation Transport Committee for the coming financial year. On capital account the Committee estimates for a total expenditure of £150,432, of which £90,000 is for the provision of new motor omnibuses and only £10,000 for new tramcars. Preston Town Council is applying to the Ministry of Transport for powers to borrow £21,440 for the purchase of motor omnibuses for the first stage of the change-over from tramcars.

A Triple-purpose Plant.

Advantages of considerable importance seem likely to result from the adoption of a solvent recovery plant, the product of a Lancashire engineering firm, Suteliffe, Speakman and Co., Ltd., Leigh, which has just been under demonstration at a large rubber-proofing works at Hollinwood, near Manchester. Besides effecting a recovery of between 85 and 90 per cent. of an expensive solvent material, employed in this particular works to the extent of 5000 to 6000 gallons weekly, there are the other important factors of a marked reduction of atmospheric pollution and a decided change for the better in working conditions for employees in waterproofing operations. Moreover, the fact that the solvent vapours are not permitted free access to the atmosphere of the proofing department, naturally makes for conditions which are less susceptible to fire and explosion risks. Besides the installation in question, others are being installed in similar Manchester works. It is understood that the process is applicable to other industrial operations of a more or less analogous character.

Fire at Horwich Locomotive Works.

Work in the No. 2 erecting shop of the London, Midland and Scottish Railway Company's locomotive works at Horwich was interrupted for a day or two in consequence of a fire which occurred last Friday. Several hundred workmen were affected.

Non-ferrous Metals.

There has been little or no improvement in the trade demand for the non-ferrous metals during the past week, and values in most sections have tended slightly lower again. In the case of tin, the statistical position generally is not being regarded any too hopefully, and interest from users here as well as in other countries is quiet. During the past week prices in this section have touched rather low levels, but those ruling at the moment of writing are above the worst, and represent a very slight improvement compared with a week ago. The copper market just now appears to be undeniably weak, and holders of stocks seem to be more anxious to dispose of them than users are ready to buy. The consequence has been a period of falling prices, with quotations on balance, in the case of standard brands, roughly £1 a ton below what they were at last report. Similarly with lead. Reports from all directions regarding the demand for the metal are uninspiring, and values have lost ground in this section to the extent of a further 5s. a ton. In spelter the supply position, notwithstanding the attempts that have been made to control it, appears to be top-heavy still, and with buying interest very subdued, prices here, also, are lower by about 5s. a ton on balance.

Iron and Steel.

The only relatively satisfactory feature about the Lancashire iron and steel markets is that deliveries of pig iron into consumption since the beginning of the year have not fallen much below the average for the past four months. There is, however, no indication as yet of new contract buying attaining important dimensions, few orders of any consequence having been reported here during the past week. Quotations remain at 67s. per ton for Derbyshire, Staffordshire, and Cleveland iron, delivered equal to Manchester; 65s. 6d. for Northamptonshire; about 87s. for Scottish; and 81s. for West Coast hematite. Trade in finished iron is slow, with Lancashire Crown quality bars at £9 15s. and No. 2 material at about £8 5s. The fact that prompt delivery of almost all classes of steel is obtainable from the mills, speaks volumes for the state of trade. Recent orders in this district for boiler and general plates, constructional material, and bars

have all been for limited quantities on a day-to-day delivery basis, and no apparent improvement in the position of the local steel-consuming industries is in sight. Small bars are quoted by re-rollers at about £7 per ton; sections at £8 7s. 6d.; joists at £8 15s.; tank plates at £8 17s. 6d.; and 3in. and upward bars at £9 7s. 6d.; boiler plates at about £8 15s. per ton for acid and basic sorts not being too strong a section of the market.

BARROW-IN-FURNESS.

Hematite.

The condition of the hematite pig iron market remains about the same. But for the fact that the steel departments at Barrow are taking a large amount of iron, much would be going into stock, and the same remark applies to other parts of the district, where iron and steel production are combined. There is still no sign of confidence in the market, and buyers are limiting their orders to immediate requirements. As regards Continental business, there is some, but the requirements abroad are by no means large, otherwise with the pound sterling standing where it does there would be a keenness to buy. The same remark applies to American buyers. It is a better class of iron which is selling the most at home at present. With so few furnaces in blast in the district, the demand for iron ore, both native and foreign, is on the light side, and the mines are low as regards output. The steel trade is quiet, and although a few orders are held and the works for the time being are engaged, fresh orders would be very welcome.

SHEFFIELD.

(From our own Correspondent.)

The Heavy Steel Trades.

THE call for open-hearth steel shows no improvement, and production is still on a comparatively small scale. It was expected that the advantages of a depreciated currency would have a favourable effect on the trade by making foreign steel dearer, but it has not stimulated demand to any useful extent so far. The proposal to subject iron and steel imports, in common with other goods, to a flat rate duty of 10 per cent. does not evoke much enthusiasm, as it is not considered sufficient to give the trade that help which it requires. Output in this district continues on about the same level as recently reported, but increasing difficulty is found in disposing of the products of the furnaces, and, unless demand improves quickly, the closing of some of them can hardly be avoided. Orders and sales have shown a falling tendency since the partial revival in the autumn tapered off. There is no better report to give with regard to the heavy manufacturing departments. Trade is very slow, alike in semi-steel, heavy forgings, and castings, and railway material, orders of a substantial character being extremely scarce. The rolling mills and crucible furnaces are poorly employed.

The Lighter Side.

The stainless steel trade continues to present one of the brightest features of the situation. There is a well-sustained demand for its products for a variety of engineering purposes, as well as for acid and corrosion-resisting steels for works use, and production is on a substantial scale. The automobile industry is one of Sheffield's best customers, and although its demands are not up to the level of a couple of years ago, they still provide a large amount of employment for the shops turning out stampings and pressings and alloy steel for wearing parts. A larger proportion of these materials is called for in respect of heavy commercial vehicles than for touring cars. The improvement in the cold-rolled steel and strip trade is maintained. The effect of the cheaper pound in raising foreign prices has been marked, with the result that imports of those materials are falling regularly, and the demand for local products is rising in proportion. Makers of permanent magnets for wireless purposes have been enjoying a good trade for some time. Down to the end of last year they had difficulty in keeping pace with the demand, and although trade has now become quieter, there is still a good amount of work on hand.

Iron and Steel Prices.

Materials used in the manufacture of special steel, such as tungsten, molybdenum, chrome and cobalt, are dearer since the country went off the gold standard, but there have been no changes in the controlled prices of iron and steel material. The official quotations for billets, pig iron and the like have not moved for a considerable time. It is thought, however, that the cost of most of the materials required in steel making is certain to go up in the near future. The expediency of keeping finished prices down as long as possible is recognised by manufacturers.

Improving Tool Trades.

On that side of the trade which produces finished steel goods conditions have improved, and the outlook is good. An increasing amount of business which formerly went to foreign firms is coming here, owing to the higher prices of imported goods. In certain classes of tools, indeed, it is believed that foreign competition is on the road to elimination, with the result that the prospects of local industry are steadily improving. The full benefit of the changed conditions is not being reaped yet, because of the heavy stocks of foreign tools in this country, prices of which have not undergone any considerable increase. These stocks could not be replaced at the present time, however, except at prices which would be prohibitive to home users, so that, when they are exhausted, there is every likelihood of a greater demand for Sheffield materials. In the meantime, users and distributors of many kinds of tools, wireless and electrical parts, and other goods, who have in the past placed their business abroad, are sending in numerous inquiries to local firms. It is fully expected that these inquiries will mature into actual business, and that then the Sheffield factories will enjoy greater activity.

The First Stainless Knives.

Mr. Harry Brearley, whose name is so well known in connection with the discovery of stainless steel, has made an interesting gift to the Cutlers' Company. It is of great historic and scientific value, as it consists of a history of the discovery of stainless steel, together with a number of specimens of the earliest stainless table knives made. The knives are now on view in the Weston Park Museum, and are to have a permanent home in the Cutlers' Hall. The history of the invention is in a sealed envelope, and a condition of the gift is that it shall not be opened until the Forfeit Feast of 1960. Mr. Brearley makes that stipulation to avoid causing inconvenience or offence, remarking that by the date mentioned "the persons concerned are unlikely to be living."

A Trade Exhibition.

There has been on view in Sheffield during this week a comprehensive exhibition of local products, chiefly of the lighter kind, which is calculated to tell the world a good deal about what the city and its neighbour Rotherham can do. The exhibition is at one of the large central stores of the city, and has attracted great attention. Over a score firms have contributed to it, and the articles on view include bakelite mouldings, cutlery of all kinds, stainless steel, drop forgings, small tools, magnets, refractory materials, water meters and sluice valves, heat-resisting steels, mining tools and machinery, garden tools, stainless steel welding, electric car washers, precision tools, files and rasps, wood boring and morticing tools, micrometers, crank shafts, vacuum cleaners, saws, gramophone needles, main springs and sound boxes, clock springs, air pumps, compressors, pressure gauges, builders' and joiners' tools, "Crysteel," silver and electro-plate, and safety razor blades. There are also a number of working exhibits. The exhibition is to be enlarged and repeated in London for a fortnight in May next.

Cutlery and Plate.

The table knife, spoon and fork departments of these trades, and also that of hollowware, are quiet. The seasonal demand has not yet begun, and business is not up to the level of a year ago. In other sections, however, conditions are better, and prospects are improving. These are the sections devoted to scissors, tailors' shears, tool knives, and surgical instruments. The difference in exchange values, coupled with the anti-dumping duty, amount to a tax equal to about 100 per cent. on goods of these classes imported from Germany, and in consequence a good deal of business has been diverted from that country and has been obtained over here. There are still heavy stocks of German products in this country, but they will be exhausted in time, and under present conditions they cannot be renewed except at prohibitive prices, so that the outlook for the Sheffield trades is bright. Buyers seem unwilling to pay more than the old German prices, however, and altogether the prevailing prices of Sheffield cutlery are on a low, and in many cases unprofitable, level. At one of the largest spoon and fork plants in the city only goods made from stainless steel are now being produced, the output including numerous fancy patterns of an attractive kind. The trade in safety razor blades is brisk, and a new order of importance, just announced, is one booked by Thos. Ward and Sons, Ltd., for the supply of safety razors and blades to the Indian Army headquarters at Simla, Cawnpore, Bombay, and other districts. The order, which is on a considerable scale, and will provide a substantial amount of work, was secured in competition with home and foreign firms. Messrs. Ward's razors and blades are also being used by the British and Free State armies. An interesting innovation in the cutlery trade is the introduction of a new stainless material named "Crysteel," invented by Mr. P. R. Kuehnrich, who has been in the Sheffield steel trade many years, and who a few years ago brought out the Darwin razor blade. The new material, for which many advantages of cutting power and durability are claimed, is being made up into knives, forks, and spoons, by the Universal Rustless Steel Corporation, Ltd., Crysteel Works, Sheffield.

Bridging the Humber.

The important proposal for the bridging of the river Humber near Hull continues to receive the attention of authorities who are interested in it, for or against. The Lindsey County Council has just decided not to withdraw its offer of £30,000 towards the cost of the bridge, providing that the contributions of Hull Corporation and other local authorities are forthcoming, and that the assistance of the Ministry of Transport is not withdrawn.

NORTH OF ENGLAND.

(From our own Correspondent.)

Iron and Steel Exports Decline.

THE serious plight of the iron and steel trade of the North of England is reflected in the record of Tees exports for the first month of 1932. A total export of 30,293 tons of iron and steel from the river during January represents the smallest total recorded since the period of the coal strike in 1926, when the industry was paralysed by the stoppage of fuel supplies. The contraction in the volume of trade extends both to pig iron and finished steel products. In December last, 11,634 tons of pig iron were shipped, whereas in January the total fell to 8436 tons, whilst in the same period the finished steel shipments fell from 25,693 tons to 21,857 tons. Of the grand total, 4491 tons of pig iron and 10,766 tons of manufactured iron and steel were shipped coastwise. Denmark was the chief foreign customer for pig iron with 1045 tons, while Belgium took 599 tons, Italy 560 tons, Germany 305 tons, and Norway 285 tons. India was by far the largest buyer of manufactured iron and steel with 2822 tons. Portuguese East Africa received 1686 tons, Argentine 1349 tons, South Africa 1122 tons, and China 609 tons.

Imports Up.

On the other hand, imports of iron and steel continue heavy. Statistics presented at this week's meeting of the Tees Conservancy Commission showed that during January 16,726 tons were imported, as against 14,543 tons in December, 18,442 tons in January last year, and 5012 tons in January, 1914. There was a light increase in the amount of pig iron brought into the river, 527 tons being imported in January compared with 473 tons in December, but for the last three months only 1280 tons of pig iron were imported, as compared with 6843 tons for the same period a year ago. The imports of semi-finished steel during January totalled 23,454 tons, as compared with 23,816 tons in December. During the past three months the unloadings reached 50,512 tons, as compared with 46,512 tons for the corresponding period of 1930–31 and 17,119 tons in the pre-war period of 1913–14.

Coal Trade Blows.

The coal trade seems quite incapable of escaping from difficulties, and the worst are not of its own making; they are of the kind over which it has little or no control. The announcement that French imports of coal are to be but 64 per cent. of the average of 1928–29–30 has caused a great deal of anxiety in North-East Coast exporting circles, which are now wrestling with the ambiguities and complications imposed by the earlier restriction of 80 per cent., applied last August, and brought down to 72 per cent. in December. Then came the 15 per cent. surtax on imports from this country to add to the difficulties. The new restriction cannot be without effect on the Northumberland and Durham market. There is a fairly steady demand in France for Durham coking coals and shipments of coking coals will be essential for blending purposes if for no other reason. Most exporters, however, attach more importance to the general inconvenience which the embargo will cause in France than they do to the specialised industries which require our coal. On top of the French trouble comes the report that Norway may restrict her coke imports, which will have a very big effect upon the Durham coke industry if it is confirmed. Durham has of recent years cultivated that market very assiduously, and many firms have prepared coke especially to meet the peculiar requirements of the Norwegian buyers. Another serious blow to exporters in this area is the reported intention of Germany to cut down imports of coal and coke by 75 per cent.

Cleveland Iron Trade.

Business in the Cleveland pig iron trade has shown a slight improvement this week, chiefly on home account; but the export trade is still very restricted. Whilst there are still complaints that a 10 per cent. duty will afford inadequate protection to the iron and steel industry, the prospect of a tariff to embrace both pig iron and crude steel, as well as the finished material, has created a more hopeful feeling, and there is now greater confidence in an early expansion of business. The whole of current output of Cleveland pig iron is going into immediate consumption, and stocks are still being drawn upon to meet requirements. Prices are firmly maintained, No. 1 Cleveland foundry iron being 61s., No. 3 G.M.B. 58s. 6d., No. 4 foundry 57s. 6d., and No. 4 forge 57s.

Hematite Pig Iron.

The first cargo of East Coast hematite pig iron for Italy this year has just been loaded in the Tees, and further sales to that country are not unlikely. The quoted price of mixed numbers is still around 64s. 6d.

Ironmaking Materials.

Foreign ore consumers are off the market. The nominal price of best Rubio ore is 16s. 6d. c.i.f. Tees. The coke market is dull, but sellers of good medium blast-furnace qualities still adhere to 17s. delivered at the works.

Manufactured Iron and Steel.

Manufactured iron and steel quotations are well upheld, but orders are still scarce. Branches best employed are those engaged on the production of constructional steel. The sheet trade, however, is showing some improvement, and £9 10s. is now a minimum figure for galvanised sheets, 24-gauge.

Iron and Steel Trade Wages.

Important wage adjustments in the North of England iron and steel trade were announced this week. The accountants for the North of England manufactured iron trades certify a reduction in the average net selling price of manufactured iron for the two months ending December 31st last, and under the sliding scale there will consequently be a reduction of 2½ per cent. in puddling and other forge and mill wages dating from Monday last. On the other hand, the steel trade ascertainments for the three months ending December 31st justify an increase of 2½ per cent. in the sliding scale percentage to operate for the three months commencing February 7th. Under this arrangement the basic scale will be 26½ per cent., and the acid scale 1½ per cent. above the standard.

The Coal Trade.

There is not much new business coming forward in the Northern coal trade, so the immediate outlook is not encouraging. Northumberland relies mostly on domestic trade, and Durham on industrial requirements. By March the household needs, never strong this season so far, will fall off rapidly, and Durham is anxiously waiting to see if safeguarding is to be given to the iron and steel trade. If blast-furnaces got into operation on a large scale once again, it would give a substantial impetus to coking and other fuels, which just now are very dull. Demands from abroad are becoming more and more limited through one cause and another; hence more home business

is what is required. Fitters in the Northumberland steam coal section are fairly well booked for early supplies, but for forward loadings the outlook is disappointing and any qualities could doubtless be obtained at the minimum. Best Northumberland steams are on offer prompt or forward at 13s. 6d. to 13s. 7½d. The Wear trade is also under dull conditions. Best Wear large steams offer at 15s. and small at 12s. There is considerable curtailment of output in all descriptions of Durham coal. Gas qualities are still, however, offered abundantly. Best sorts can be obtained at 14s. 6d. and secondary at 13s. 6d. The prime Wear qualities are in good supply at 15s. Durham coking unscreened are difficult to clear at 13s. to 13s. 6d., and coking small at 12s. 6d. to 13s. 3d. Bunkers are moving very slowly and stocks are plentiful. Best quality bunkers are easy at 14s. and secondaries at 13s. Gas coke is heavily sold and stocks are down to a very low total, the daily production being fully taken up. Prices are unchanged but firm at 19s. for best kinds. Patent oven coke is plentiful and weakly held at 16s. to 17s. Superior foundry coke is steady at 18s. to 21s. Coke nuts are in limited supply at 19s. to 21s.

Ship Repairing Activity.

There is a marked improvement in ship repairing on the North-East Coast, and the prospect is reported to be much brighter. Not a single firm, however, is working at anything like its normal capacity. The overhauling of five large Ellerman liners is to be carried out by Armstrong, Whitworth, Ltd., at the Scotswood Works, Newcastle, and will consist mainly of machinery modifications.

SCOTLAND.

(From our own Correspondent.)

Shipbuilding.

THE output from Clyde yards for January, 1932, only amounted to two vessels of 1888 tons aggregate. A large proportion of the tonnage on hand in Clyde yards is in the early stage of construction, and if work in the Cunarder had not been suspended the position, so far as employment is concerned, would have been better than for some time. Meanwhile, the situation on the lower reaches is better than in the Glasgow area. New orders during last month are represented by one order placed with William Denny and Brothers, Ltd., Dumbarton, on behalf of the Southern Railway Company, for a steamer of about 2288 tons for the Newhaven–Dieppe service.

Steel.

Though it has been said that a better feeling exists in the steel industry, the more hopeful attitude is not the result of any increase in business. It is estimated that only about 30 per cent. of the plants are in operation, and there is no definite indication of any increase in demand. Heavy steel is very poorly specified, the dearth of shipbuilding orders affecting plates and sections. Sheetmakers, on the other hand, are comparatively well placed. Business has increased of late. Light sheets are well supplied with orders, the demand continues to increase, and the inquiry is well maintained, and so long as the raw materials are not subjected to tariffs the future appears favourable. Steel tubes are not experiencing any improvement in demand, and a curtailment of employment would appear inevitable, and may be resorted to when the fusion of the interests of Stewarts and Lloyds, Ltd., and the Scottish Tube Company, Ltd., is ratified by the shareholders of the first-named company within the next few days.

Iron.

Bar iron makers have not improved their position since the last cut in the home price, both home and export demands being extremely limited. Steel re-rollers indulging in price-cutting find business small and barely remunerative, with the home quotation at £6 5s. and export at £6 2s. 6d. per ton.

Pig Iron.

The output from the five furnaces in blast in Scotland is still ample to meet all demands. Considerable quantities continue to arrive from India, the latest consignment unloaded last week amounting to over 8000 tons. A cargo of 500 tons also arrived from Millom. Shipments from Glasgow only amounted to 129 tons (50 tons foreign), compared with 48 tons (14 tons foreign) in the same week last year.

Scrap.

The scrap market remains quiet, but prices are without change, with cast iron machinery at 57s. 6d. to 60s. per ton, and heavy steel at 42s. 6d. per ton.

Coal.

In the Scottish coal market the depression tends to increase. Home demands remain considerably below the usual seasonal requirements and collieries have rarely been able to secure a price higher than "summer" rates. Foreign demands continue to diminish. Importers abroad are not disposed to consider present colliery prices for delivery over a period, and shippers are not prepared to risk anything in the nature of speculative selling. Business, therefore, is confined to small prompt orders, apart from increased difficulties, caused by the restriction of imports to Continental countries and a further increase in the French import tariff. Scottish collieries as a rule find it increasingly difficult to dispose of outputs. Lanarkshire splints are, in fact, the only description to maintain a firm attitude. Washed materials, especially treble and double nuts, show further weakness. Aggregate shipments amounted to 256,039 tons, against 242,745 tons in the preceding week, and 205,564 tons in the same week last year.

WALES AND ADJOINING COUNTIES.

(From our own Correspondent.)

The Coal Trade.

SINCE writing a week ago, the position of steam coal producers has become worse rather than better, and the outlook gives rise to anxiety. Shipments last week, according to the G.W.R. Company's returns, were 402,120 tons, which compared with 477,430 tons for the preceding week, and with 443,603 tons for the corresponding period of last year. The situation, from a tonnage point of view, at the end of the week, was that forty-five vacant loading berths were reported at the various docks, while on Monday the position was not a great deal improved, as the total of vacant berths was only reduced to thirty-seven, though seven steamers were waiting to berth, of which six were at Swansea. It is not surprising, therefore, that numbers of collieries are working short time, and, as new business for prompt loading is negligible, there is not much hope of pits working more regularly. But, apart from the loading position, there is the news that the French Government has decided to limit still further the imports of coal as from February 1st. Whereas up to the end of January imports were on the basis of 70 per cent. of the average monthly quantities imported during the three years 1928, 1929 and 1930, the decision has been officially made known that, as from the beginning of this month, there is to be a further reduction of 8 per cent., making the percentage 64 per cent. South Wales, of course, suffers relatively to a greater extent than other exporting areas in this country, as this district ships about 55 per cent. of the total quantity sent from the United Kingdom to France. It should be pointed out that duff coals for patent fuel and ovoid manufacture are excluded from the operation of the quota, while coking smalls are exempt from licence though the restrictions on the importation of those qualities have been tightened up, and it must now be certified by coke manufacturers that the coals are for their use. The 8 per cent. reduction in coal imports applies to coals of any origin, but that does not afford any satisfaction to this area, more especially as the 15 per cent. surtax continues to be imposed on British coals only. The report comes from Paris that the French Government has reserved to itself the right to exceed the percentage of 64 by 6 per cent. to meet the needs of certain centres situated at a distance from French mines, and that there is a probability of a permanent percentage of 70 being established in the near future. There can be no doubt that the French coal industry is in a very depressed state, and the miners in Northern France are taking a referendum on the 7th inst. as to whether a general strike shall be called as a reply to the decision of the coalowners that wages shall be reduced by 10 per cent. It is very unlikely, however, that the men will strike. If they did, the probability is that the French Government would at once modify its decision regarding the limitation of coal imports, which would be beneficial to Anglo-French trade. As things are, however, this trade is quieter than ever, and shipowners interested in the short trades are finding it more difficult than ever to secure remunerative business. In fact, outward rates of freight for coal are worse, and unless there is a change very shortly there can be no doubt that owners will be compelled to lay up their boats on a greater scale than at present. The inquiry all round for steam coals is extremely disappointing. The Norte Railway of Spain have purchased four cargoes amounting to about 15,000 tons of Admiralty coals for shipment over two months, and the Andalusian Railway of Spain has asked for prices for 21,000 tons to be shipped by October, but otherwise the market displays a featureless appearance.

Quick Dispatch.

Reference has previously been made to the efforts to improve the dispatch of steamers loading or bunkering in this Channel, and this question has involved the control of the coal-trimmers. Under the present system the trimmers are under joint control, which is regarded as unsatisfactory. The trimmers' representatives on the Joint Control Board for Cardiff, Penarth and Barry were on Monday advised of the suggestions which were put forward by the shipowners' representatives for improving the situation, and among the alterations to the rules was one that the control of the trimmers on the dockside must be in the hands of the employers' representatives only, but that the present Joint Control Board should still continue to function and deal with all matters arising out of the National Coal Trimming Tariff and act as a Court of Appeal in disciplinary cases. The suggested alterations in the rules were considered on Monday by the executive of the Coal Trimmers' Union, and on Tuesday their representatives met the employers' representatives, but no decision was come to, and it is probable that the matter will be laid before a Bristol Channel delegate conference, and from that body referred to the workmen for ultimate decision.

Landore Works to Resume Operations.

It is reported that work is to be resumed at the four steel furnaces and bar mill at Landore Works of Baldwins, Ltd. These works have been at a standstill for the last twelve months, but operations are to be restarted by the end of this month at the latest, and it is expected that work will be provided for approximately 450 men. This follows upon the resumption of work at the Elba Tin-plate Works, which look to the Landore Works for a considerable portion of their bars, though, at the same time, hopes are entertained that there will be an improvement in the steel trade before long, especially if foreign imports of bars are restricted.

Cardiff's Aerodrome.

Cardiff's Finance Committee decided on Monday to spend a further £6000 on the Splott aerodrome, subject to the confirmation of the City Council. The sum of £19,000 has already been laid out on the site, and the additional sum includes £4000 for various works, such as approaches, fencing, &c., and £2000 for the hangar, apron, ground lettering, &c. The City Treasurer stated that the new expenditure would have to be incurred in order to get the licence, whilst a member of the Committee said that there would be no difficulty in getting landing licences for expert pilots, but they could not get a licence for training purposes until the ground was fully equipped with hangar, &c. It was further pointed out that unless the extra £6000 was spent, the £19,000 already expended would have been laid out in vain.

Docks Traffic.

Returns issued by the Great Western Railway Company in respect of the traffic at the six docks in this area under its control show that for the four weeks ended January 17th imports came to 253,447 tons, and exports to 1,716,747 tons, making an aggregate of 1,970,194 tons. The figures from January 1st to 17th were: imports, 129,289 tons, which compares with 175,376 tons for the same period of last year, and exports 945,964 tons, as against 677,787 tons, making an aggregate of imports and exports of 1,075,253 tons, compared with 853,163 tons for the same period of 1931.

Current Business.

The general tone of the steam coal market remains very quiet in all departments, and there are no price movements of coals to create any interest. The demand from all directions is so limited that collieries are unable to get sufficient business to absorb their already limited production. For the few inquiries which are received there is the severest possible competition, and the c.i.f. prices which are quoted cannot leave much, if any, profit at all when the business is secured. All grades of coal are freely obtainable, while coke is only just about steady and patent fuel orders are scarce. As regards pitwood, Portuguese supplies are quoted at 23s. to 23s. 6d., while French wood is round about 24s. to 24s. 6d.

PERSONAL AND BUSINESS ANNOUNCEMENTS.

MR. S. MCLEAN, until lately director of Daniel Adamson and Co., Ltd., has joined the staff of Hick, Hargreaves and Co., Ltd., and will take charge of that company's turbine, turbo-compressor, turbo-blower and rotary-compressor sales.

COX AND DANES, Ltd., of Stevenson-road, Sheffield, ask us to announce that they have appointed Mr. J. Farrer, of 50, Grosvenor-gardens, Jesmond, Newcastle-on-Tyne, as their representative on the North-East Coast. Mr. Farrer will deal with the whole of the firm's scrap business in that area.

THE directors of the International Automatic Telephone Company, Ltd., ask us to announce that Mr. E. A. Mellinger and Mr. H. L. Harris have resigned their directorships, and that Sir Max Muspratt, Bart., Mr. John Ferguson, M. Inst. C.E., and Mr. G. H. Nisbett, M.I.E.E., have been appointed to take their places.

MR. D. S. PAXTON, A.M.I.E.E., of Oxford-road, Macclesfield, asks us to announce that after an association extending over twenty years with the Brown-Boveri organisation, he recently joined Daniel Adamson and Co., Ltd., Dukinfield, and has proceeded to India from Marseilles on February 1st, in order to take over the management of that company's Indian branch.

THE AUTOMATIC TELEPHONE MANUFACTURING COMPANY, Ltd., asks us to announce that the name of the company has been changed to Automatic Electric Company, Ltd. Mr. G. W. Moore has been appointed deputy chairman of the company, and the following directors, Mr. E. A. Mellinger, Mr. H. L. Harris, Mr. D. Johnstone Sinclair, and Sir Max Muspratt, Bart., having resigned, Messrs. T. A. Eades, A. F. Bennett, and J. Nixon have been appointed to take their places.

FARMER, STEDALL AND CO., of 145 to 157, St. John-street, Clerkenwell, London, E.C. 1, ask us to announce that their machine tool and small tool department will in future be known as Stedall-Dowding Machine Tool Company, with Mr. Guy F. Dowding, A.M.I. Mech. E., as general manager. This arrangement will also incorporate the former business and connections of Dowdings' Machine Tool Company, Ltd., of Vauxhall, the goodwill of that company having been purchased by Farmer, Stedall and Co., who have also acquired the shares of the Birmingham Bureau of Standards and Measurement, Ltd. The Reinecker sales office which for the past twelve months was carried on at Vauxhall has accordingly been transferred to St. John-street, Clerkenwell.

CALENDARS, DIARIES, &c.

BELL'S ASBESTOS AND ENGINEERING SUPPLIES, Ltd., Bestobell Works, Slough, Bucks.—Calendar with monthly tear-off sheets.

FLEETWAY PRESS (1930), Ltd., 3–9, Dane-street, High Holborn, W.C. 1.—Wall calendar with monthly tear-off sheets.

INTERNATIONAL CONSTRUCTION COMPANY, Ltd., 56, Kingsway, W.C. 2.—Wall calendar with monthly tear-off sheets.

CATALOGUES.

ENGLISH ELECTRIC COMPANY, Ltd., Stafford.—Publication M 76 on Mercury Arc Rectifiers.

PAINTER BROS., Ltd., Hereford.—Details of various forms of steel poles for electric transmission lines.

JOHN LANG AND SONS, Ltd., Johnstone, Glasgow.—A catalogue of some 170 pages on modern high-speed lathes.

HADFIELDS, Ltd., East Hecla and Hecla Works, Sheffield.—Pamphlet 328 on revolving screens of special steel construction.

DONOVAN AND CO., 47, Cornwall-street, Birmingham.—Particulars of apparatus for the control of circuits up to 660 volts.

DORMAN, LONG AND CO., Ltd., 55, Broadway, S.W. 1.—An interesting booklet dealing with "Cuprador" copper bearing steel.

MORSE CHAIN COMPANY, Ltd., Letchworth, Herts.—A leaflet giving full particulars of the inverted tooth type Morse chain couplings.

TAYLOR STOKER COMPANY, Ltd., Bush House, Aldwych, W.C. 2.—A brochure illustrating and giving some particulars of marine stokers.

WALTER SLINGSBY AND CO., Ltd., Woodhouse-road, Keighley, —Catalogue 171, a very comprehensive illustrated list of malleable pipe fittings.

Current Prices for Metals and Fuels.

IRON ORE.

N.W. COAST—	
(1) Native	16/6 to 20/–
(1) Spanish	17/– to 21/–
N.E. COAST—	
Native	18/– to 21/–
Foreign (c.i.f.)	16/6 to 17/–

PIG IRON.

	Home. £ s. d.	Export. £ s. d.
(2) SCOTLAND—		
Hematite	3 8 6	—
No. 1 Foundry	3 12 0	—
No. 3 Foundry	3 9 6	—
N.E. COAST—		
Hematite Mixed Nos.	3 4 6	3 4 6
No. 1	3 5 0	3 5 0
Cleveland—		
No. 1	3 1 6	3 1 0
Siliceous Iron	3 1 0	3 1 0
No. 3 G.M.B.	2 18 6	2 18 6
No. 4 Foundry	2 17 6	2 17 6
No. 4 Forge	2 17 0	2 17 0
Mottled	2 16 6	2 16 6
White	2 16 6	2 16 6
MIDLANDS—		
(c) Staffs.—	(*Delivered to Station*).	
All-mine (Cold Blast)	—	—
North Staffs. Forge	3 1 0	—
„ „ Foundry	3 6 0	—
(c) Northampton—		
Foundry No. 3	3 2 6	—
Forge	2 17 6	—
(c) Derbyshire—		
No. 3 Foundry	3 6 0	—
Forge	3 1 0	—
(3) Lincolnshire—		
No. 3 Foundry	—	—
No. 4 Forge	—	—
Basic	—	—
(4) N.W. COAST—		
N. Lancs. and Cum.—		
Hematite Mixed Nos.	3 15 6 (a); 4 0 6 (b); 4 5 6 (c)	—

MANUFACTURED IRON.

	Home. £ s. d.	Export. £ s. d.
SCOTLAND—		
Crown Bars	9 15 0	9 5 0
Best	—	—
N.E. COAST—		
Iron Rivets	11 5 0	—
Common Bars	10 10 0	—
Best Bars	11 0 0	—
Double Best Bars	11 10 0	—
Treble Best Bars	12 0 0	—
LANCS.—		
Crown Bars	9 15 6	—
Second Quality Bars	8 5 0	—
Hoops	12 0 0	—
S. YORKS.—		
Crown Bars	9 15 0	—
Best Bars	10 15 0	—
Hoops	12 0 0	—
MIDLANDS—		
Crown Bars	9 5 0 to 10 7 6	—
Marked Bars (Staffs.)	12 0 0	—
Nut and Bolt Bars	8 7 6	—
Gas Tube Strip	10 10 0 to 10 12 6	—

STEEL. (d)

	(6) Home. £ s. d.	(7) Export. £ s. d.
(5) SCOTLAND—		
Boiler Plates (Marine)	9 0 0	8 10 0
„ „ (Land)	—	—
Ship Plates, ½in. and up	8 15 0	7 15 0
Sections	8 7 6	7 7 6
Steel Sheets, ¼in.	7 10 0	7 10 0
Sheets (Gal. Cor. 24 B.G.	10 5 0	9 10 0

STEEL (*continued*).

	Home. £ s. d.	Export. £ s. d.
N.E. COAST—		
Ship Plates	8 15 0	7 15 0
Angles	8 7 6	7 7 6
Boiler Plates (Marine)	10 10 0	—
„ „ (Land)	10 0 0	—
Joists	8 15 0	7 7 6
Heavy Rails	8 10 0	—
Fish-plates	12 0 0	—
Channels	10 5 0	£9 to £9 5s.
Hard Billets	8 2 6	—
Soft Billets	6 17 6	—
N.W. COAST—		
BARROW—		
Heavy Rails	8 5 0	—
Light Rails	8 10 0 to 8 15 0	—
Billets	6 10 0 to 9 0 0	—
MANCHESTER—		
Bars (Round)	9 7 6	—
„ (Small Round)	7 0 0	—
Hoops (Baling)	10 0 0	9 15 0
„ (Soft Steel)	9 0 0	8 15 0
Plates	8 17 6 to 9 2 6	—
„ (Lancs. Boiler)	8 15 0	—
SHEFFIELD—		
Siemens Acid Billets	9 2 6 (basis)	—
Hard Basic	8 2 6 and 8 12 6	—
Intermediate Basic	6 12 6 and 7 2 6	—
Soft Basic	6 0 0	—
Hoops	9 10 0 to 9 15 0	—
Soft Wire Rods	7 10 0	—
MIDLANDS—		
Small Rolled Bars (all British)	7 15 0 to 8 0 0	—
Small Re-rolled Bars	6 17 6 to 7 0 0	—
Billets and Sheet Bars	5 7 6 to 5 10 0	—
Galv. Sheets, f.o.b. L'pool	9 7 6 to 9 10 0	—
(3) Staffordshire Hoops	9 10 0	—
(d) Angles	8 7 6	—
(d) Joists	8 15 0	—
(d) Tees	9 7 6	—
(d) Bridge and Tank Plates	8 17 6	—
Boiler Plates	8 12 6	—

NON-FERROUS METALS.

SWANSEA—	
Tin-plates, I.C., 20 by 14 f.o.b.	14/3 to 14/9
Block Tin (cash)	140 17 6
„ (three months)	143 10 0
Copper (cash)	38 3 9
„ (three months)	39 1 3
Spanish Lead (cash)	14 12 6
„ „ (three months)	14 15 0
Spelter (cash)	14 3 9
„ (three months)	14 11 3
MANCHESTER—	
Copper, Best Selected Ingots	41 0 0
„ Electrolytic	45 0 0
„ Strong Sheets	72 0 0
„ Tubes (Basis Price), lb.	0 0 11
Brass Tubes (Basis Price), lb.	0 0 9½
„ Condenser, lb.	0 1 0
Lead, English	16 2 6
„ Foreign	14 15 0
Spelter	14 10 0
Aluminium (per ton—raw ingot)	£95

FERRO ALLOYS.

	Per Ton.	Per Unit.
Tungsten Metal Powder	2/4 per lb.	
Ferro Tungsten	2/– per lb.	
Ferro Chrome, 4 p.c. to 6 p.c. carbon	£24 12 6	7/–
„ „ 6 p.c. to 8 p.c.	£23 10 0	7/–
„ „ 8 p.c. to 10 p.c.	£22 15 0	6/6
„ „ Specially Refined		
„ „ Max. 2 p.c. carbon	£36 10 0	10/–
„ „ „ 1 p.c. carbon	£43 10 0	12 –
„ „ „ 0·70 p.c. carbon	£52 10 0	13/–
„ „ „ carbon free	11d. per lb.	
Metallic Chromium	3/1 per lb.	
Ferro Manganese (per ton)	£11 0 0 for home	
„ „ „	£11 10 0 for export	
„ Silicon, 45 p.c. to 50 p.c.	£9 15 0 scale 5/– per unit	
„ „ 75 p.c.	£15 10 0 scale 7/– per unit	
„ Vanadium	12/9 per lb.	
„ Molybdenum	6/3 per lb.	
„ Titanium (carbon free)	9d. per lb.	
Nickel (per ton)	£250 to £255	
Ferro Cobalt	10/– per lb.	

FUELS.

SCOTLAND.

	Export.
LANARKSHIRE—	
(f.o.b. Glasgow)—Steam	13/– to 13/3
„ „ Ell	14/3
„ „ Splint	14/3 to 16/–
„ „ Trebles	13/6
„ „ Doubles	11/9
„ „ Singles	9/6
AYRSHIRE—	
(f.o.b. Ports)—Steam	13/–
„ „ Jewel	17/–
„ „ Trebles	13/9 to 14/–
FIFESHIRE—	
(f.o.b. Methil or Burntisland)—Steam	12/3 to 13/6
Screened Navigation	16/6
Trebles	13/6
Doubles	11/6
Singles	9/9
LOTHIANS—	
(f.o.b. Leith)—Best Steam	12/3
Secondary Steam	12/–
Trebles	13/6
Doubles	11/6
Singles	10/–

(8) N.W. COAST— ENGLAND.

Steams	21/9
Household	32/6 to 51/3
Coke	20/3 to 22/6
NORTHUMBERLAND—	
Best Steams	13/9
Second Steams	12/3 to 12/6
Steam Smalls	8/6 to 9/–
Unscreened	12/6 to 13/–
Household	27/– to 39/–
DURHAM—	
Best Gas	14/6
Second	13/6
Household	25/– to 37/–
Foundry Coke	24/–
SHEFFIELD—	Inland.
Best Hand-picked Branch	26/6 to 27/6 —
South Yorkshire Best	23/6 to 24/– —
Derbyshire Best Bright House	19/– to 20/6 —
Best House Coal	22/– to 23/– —
Screened House Coal	19/– to 20/6 —
Best Screened Nuts	17/– to 18/– —
Small Screened Nuts	14/6 to 15/6 —
Yorkshire Hards	16/– to 18/– —
Derbyshire Hards	16/– to 18/– —
Rough Slacks	8/6 to 9/6 —
Nutty Slacks	7/– to 8/6 —
Smalls	5/6 to 6/6 —
Blast-furnace Coke (Inland)	12/– to 12/6 on rail at ovens
Furnace and Foundry Coke (Export), f.o.b., 18/– to 18/6	

CARDIFF— (9) SOUTH WALES.

Steam Coals:	
Best Smokeless Large	19/6 to 19/9
Second Smokeless Large	18/9 to 19/6
Best Dry Large	19/– to 19/6
Ordinary Dry Large	17/9 to 18/3
Best Black Vein Large	18/3 to 18/6
Western Valley Large	17/9 to 18/–
Best Eastern Valley Large	17/7½ to 17/9
Ordinary Eastern Valley Large	17/3 to 17/6
Best Steam Smalls	13/– to 13/6
Ordinary Smalls	11/– to 13/–
Washed Nuts	19/– to 27/–
No. 3 Rhondda Large	19/9 to 20/–
„ „ Smalls	15/– to 16/–
No. 2 „ Large	17/– to 17/3
„ „ Through	15/6 to 16/–
„ „ Smalls	14/– to 14/3
Foundry Coke (Export)	22/6 to 36/6
Furnace Coke (Export)	17/– to 18/–
Patent Fuel	19/– to 19/3
Pitwood (ex ship)	22/6 to 24/–
SWANSEA—	
Anthracite Coals:	
Best Big Vein Large	36/– to 38/6
Seconds	27/– to 32/6
Red Vein	22/6 to 27/6
Machine-made Cobbles	41/6 to 43/6
Nuts	40/– to 43/6
Beans	29/6 to 32/6
Peas	19/– to 21/–
Breaker Duff	8/6 to 9/6
Rubbly Culm	8/3 to 8/9
Steam Coals:	
Large	20/– to 20/6
Seconds	18/– to 20/–
Smalls	11/6 to 13/–
Cargo Through	16/– to 17/6

(1) Delivered. (2) Net Makers' Works. (3) f.o.b. Makers' Works, approximate. (4) Delivered Sheffield. (5) Glasgow, Lanarkshire and Ayrshire. (6) Home Prices—All delivered Glasgow Station. (7) Export Prices—f.o.b. Glasgow. (8) Except where otherwise indicated, coals are per ton at pit for inland and f.o.b. for export, and coke is per ton on rail at ovens and f.o.b. for export. (9) Per ton f.o.b. (a) Delivered Glasgow. (b) Delivered Sheffield: (c) Delivered Birmingham. (d) Rebate; Joists (minimum), 22/6; Ordinary Ship, Bridge, and Tank Plates and Sections, 15/– if home consumers confine purchases from associated British Steel Makers. (e) Delivered Black Country Stations.

French Engineering Notes.

(From our own Correspondent in Paris.)

The Steel Organisation.

CONTINENTAL steel producers have all fallen in with the general lines for the reconstitution of the sales organisation for semi-manufactured steel and joists, and the comptoir would probably have been definitely established if it were not for the temporary breaking down of negotiations for the Steel Cartel. The comptoir cannot operate without the Cartel, which fixes the production of steel and thereby limits the quantity of products available for sale by each country. At the last meeting in Paris it was hoped that the negotiations for the Cartel would have been satisfactorily completed, but Belgium insisted upon a further increase of quota, which would bring its total up to 14·5 per cent. The French refused to accept this augmentation which the Belgians justified by their heavier steel production during the past year. The French allege that the Belgians have been forcing their steel output purposely with a view to claiming a bigger quota. Belgian steelmakers have not even been able to settle the distribution of the quota amongst themselves, and the matter will probably be submitted to arbitration; but it is believed that enough progress has been made to justify another meeting of the Cartel to be held in Paris during the present week. It is felt that no effort must be spared to prevent a collapse of the Cartel, the existence of which has become more than ever necessary to the welfare of the steel industry. If, as is believed amongst Continental steelmakers, the new British Tariff Bill institutes a general import duty which will cover iron and steel, it is evident that even a 10 per cent. duty would be an appreciable addition to the handicap which the depreciation of the pound has imposed upon them in their dealings with Great Britain. There is no illusion about an expanding British market for foreign steel products, and, therefore, it is argued that the Cartel must be formed to allow of the production being adjusted to the consumption.

Coal Imports.

An announcement that the Government has decided to reduce the imports of coal during February from 72 to 64 per cent. of the quantities imported before the quota was instituted, is causing considerable dissatisfaction amongst consumers, and it is all the more unexpected because the Government had formally declared that there could be no further restriction of coal imports, to which all the Ministerial Departments were opposed. If the announcement is officially confirmed, the reduction of the quota can only have been imposed upon the Government by the pressure of events in the French coalfields, where the miners have received notices of a reduction in wages of 10 per cent. In the Nord and the Pas de Calais the men have, so far, refused the reduction, and in the Loire the situation is worse, because coalowners there are now meeting with competition from the northern collieries. If the price of coal is not reduced, there will be trouble with consumers, who object to be shouldered with the burden of making good any falling off in coalowners' receipts and of paying more for their coal at a time when they must get down production costs.

The New Battleship.

When the Chamber of Deputies adopted the further instalment of the programme of naval construction for the present year, it refused the inclusion of a battleship on the ground that the explanations of the Minister of Marine were not sufficiently conclusive as regarded the character of the vessel, and of the expediency of building it at the present moment. The Chamber was under the impression that the Government had not settled upon definite plans for the battleship. During the past week the Minister of Marine presented the plans and satisfied the Commission of Marine of the Chamber, which approved the construction of a warship of 26,500 tons. It is therefore practically certain that the proposal will be accepted by the Chamber of Deputies.

Naval Ports.

The reconstitution of the French Navy has necessitated the carrying out of important works at the ports to provide for the docking and manœuvring of far longer ships than those which the new vessels have replaced. The change in the character of the fleet has also modified the general equipment of the ports, and there is, necessarily, a complete transformation of the industrial installations and the construction of new defence works. All this work involves an increasing expenditure. The port of Cherbourg is being transformed, not only for the Navy, but also for the Transatlantic liners, which will, in future, enter the harbour instead of remaining outside for embarking and disembarking passengers. It will be a torpedo boat centre, for which purpose works are being carried out on the Homet wharf. Brest is regarded as the safest naval port on the Continent, with almost unlimited anchorage, but the arsenal is at the end of the Penfeld channel, which will have to be straightened in order to facilitate the passage of the new cruisers and destroyers. At Toulon and Bizerta the works will make those centres of submarines and torpedo boats as efficient and impregnable as possible, and, in all cases, the defence works are being carried out particularly for protection against aircraft.

The Transatlantique.

The Financial Commission of the Senate has, for the second time, rejected the Government scheme to refloat the Compagnie Générale Transatlantique as a State-managed concern, and confirms that any financial aid by the State must be limited to what is necessary for the Ministry of the Merchant Marine to carry on the services during a period of reorganisation. The amount to be devoted to that purpose must not exceed 50 million francs, and then only on condition that the former directors make a substantial contribution to the fund. It is also conditional on the Government introducing a Bill during the next six months for a reorganisation of the company's services, as well as those of other shipping companies receiving subsidies from the State.

British Patent Specifications.

When an invention is communicated from abroad the name and address of the communicator are printed in italics.

When an abridgment is not illustrated the Specification is without drawings.

Copies of Specifications may be obtained at the Patent Office, Sale Branch, 25, Southampton-buildings, Chancery-lane, W.C., at 1s. each.

The date first given is the date of application; the second date, at the end of the abridgment, is the date of the acceptance of the complete Specification.

INTERNAL COMBUSTION ENGINES.

363,560. March 3rd, 1931.—INJECTION VALVES, Swiss Locomotive and Machine Works, Winterthur, Switzerland.

In order to cool the fuel injection valve, the body of the valve A is surrounded by a sleeve B, which has a hollow space at C, that is

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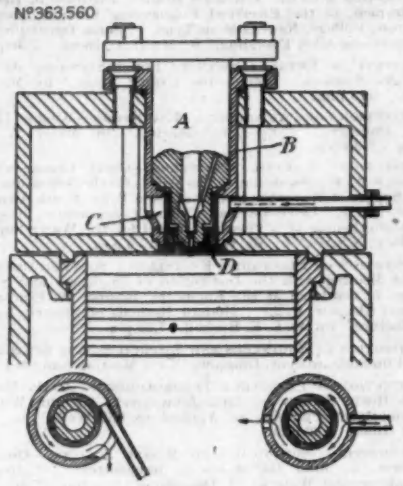

closed at the bottom by the nut D. Water is supplied to this space at a high velocity to ensure thorough cooling and escapes, presumably, into the water jacket of the cylinder head.—*December 24th*, 1931.

SWITCHGEAR.

363,437. October 1st, 1930.—ELECTRIC CIRCUIT INTERRUPTING SYSTEMS, *The British Thomson-Houston Company, Ltd., of Crown House, Aldwych, London, W.C. 2.*

As in oil circuit breakers there is a risk that the contacts may not separate to the extent necessary to clear an exceptionally large overload or short circuit, it is proposed in this specification to provide an auxiliary circuit interrupting device. Under normal conditions, the bridging member A breaks the circuit:

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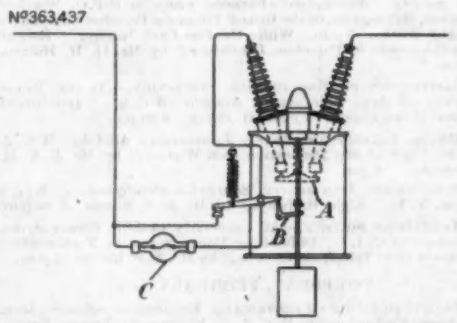

At a predetermined point, however, the catch B is released and the auxiliary circuit breaking device C is inserted in the circuit. Thus, if the arc at the main contacts persists, the circuit is broken by the device C, which takes the form of a high-tension vacuum fuse which has a circuit interrupting capacity comparable with or greater than that of the main circuit breaker. An alternative scheme utilising a current transformer and solenoid for inserting the fuse in the circuit is also described.—*December 24th*, 1931.

TRANSMISSION OF POWER.

363,533. January 28th, 1931.—ELECTRIC CABLES, John Hamilton Roberts, of Cable Research House, Silver-street, London, W.C. 1; Ernest Arthur Bayles, of "The Oaks," Helsby, Cheshire; John Bowyer, of "The Beeches," Pennington, Leigh, Lancashire; and Charles James Beaver, of Bell-place, Stamford-road, Bowdon, Cheshire.

The object of this invention is to provide a construction of a H.T. cable, and particularly a trailing cable, that will render it free from serious deteriorating influence due to the action of ozone on the rubber of the insulation or of the sheath. Each

Nº363,533

core has a conductor A and a dielectric of rubber B. The rubber dielectric is disposed between layers C and D of ozone-resisting material. Cotton tape E proofed with rubber is wound over the layer D. The spaces between the three cores are filled up by a centre F and fillings G, the centre and the fillings being made of ozone-resisting material. The laid-up cores are enclosed within a sheath H of ozone-resisting material and a tough rubber sheath J is provided over the sheath H. The sheath J is covered with an armouring K consisting of a single layer of relatively large wires, and the armouring is bound tightly on to the surface of the sheath J by means of strong cotton tapes. The latter are not shown in the drawings. When the cable is vulcanised, the armouring becomes more or less completely embedded in the tough rubber sheath J, and the layers C and D join up with the surfaces of the rubber dielectric B. The sheath H is vulcanised on to the inner surface of the tough rubber sheath J. With this form of construction all air is excluded from the surfaces of the rubber dielectric and also of the tough rubber sheath. In addition, the sheath H, fillers G and centre F provide for the complete embedding of the cores in the ozone-resisting material and thereby exclude air. The fillers and centre, however, are not vulcanised to the cores so that the latter are able to move relatively to each other when the cable is bent. After the cable has been vulcanised the tape lappings around the armouring K may or may not be removed.—*December 24th*, 1931.

363,384. September 11th, 1930.—ELECTRIC CABLE-END CONSTRUCTIONS, Micafil Aktiengesellschaft, of Zurich-Altstetten, Switzerland.

This specification describes a high-voltage cable end construction for the purpose of obtaining a uniform distribution of voltage in the longitudinal direction of the cable. A denotes the high-voltage cable, the metallic sheath B of which is widened to a funnel shape inside the end connection, and C is the usual cable insulation. The latter is thickened in such a way that it not only fills up the funnel of the metallic casing, but encloses the latter, the thickness of the insulating layer being gradually tapered in the edge of the funnel away towards the end of the cable. Over this thickened cable insulation is slipped an insulating sleeve D, which contains conducting metallic insertions, that are so distributed along the length of the sleeve and are so dimensioned that a uniform distribution of voltage along the sleeve is obtained, and therefore, at the same time, along the reinforced cable insulation. The space between the thickened cable insulation and the sleeve provided with insertions is filled with oil. The cable end thus equipped is introduced into an oil-filled insulating sleeve E which serves as an outer cover and is equipped at one end with a metallic foot member F with fastening flanges and at the other end with a metallic head member G for the expansion of the oil. The conducting insertion of the sleeve D adjacent to the foot member is conductively connected with the metallic body of the foot, so that both are at earth potential, while the potential to earth increases uniformly throughout the length of the sleeve. In order to diminish the marginal stress on the funnel of the cable sheath a ring electrode H may be embedded in the thickened insulation, which is only capacitatively coupled with the funnel.—*December 11th*, 1931.

Nº363,384

FURNACES.

363,396. September 11th, 1930.—PULVERISED FUEL BURNERS, W. A. White and White's Marine Engineering Company, Ltd., Prince Consort-road, Hebburn-on-Tyne.

In this burner the powdered fuel is supplied by the tangential branch A to the space B, so that it issues with a swirling movement. The primary air is introduced through the sleeve C

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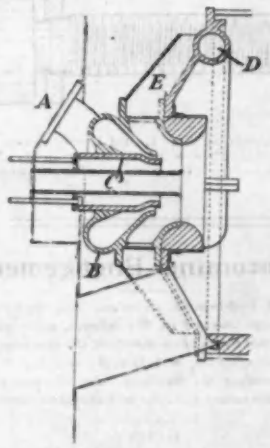


which is furnished with curved vanes that give the air a rotation contrary to that of the fuel. This sleeve can be slid back and forth to regulate the opening for the fuel. The primary air is preheated by being passed through the passage D, which is subject to the radiant heat of the furnace. Secondary air is introduced through the cone E.—*December 11th*, 1931.

WELDING.

363,921. March 26th, 1931.—ARC-WELDING RODS, Société Anonyme des Ateliers de Sécheron, Avenue Blanc, Geneva, Switzerland.

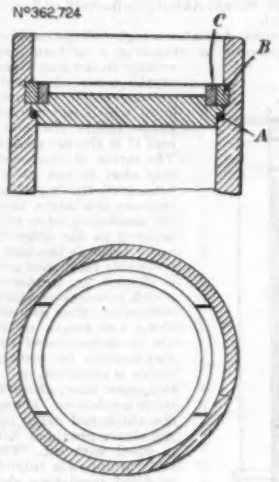
The following mixture is an example of a composition for the envelope of a rod used for arc welding:—50 per cent. aluminium "thermit," 15 per cent. silicon "thermit," 15 per cent. manganese "thermit," 5 per cent. carbonates, 5 per cent. hydrates, and 10 per cent. other substances. The whole is held together with water glass or other binding agent. The remaining 10 per cent. may consist of flux agents, basic or acidic minerals, substances it is desired to alloy with the weld, or mixtures of these materials. For example, 5 per cent. ferrochrome and 5 per cent. silicic acid, or 5 per cent. ferromolybdenum and 5 per cent. lime, or simply 10 per cent. borax may be incorporated in the welding rod envelope, according to the properties it is desired to impart to the envelope and to the weld. The envelope should have a lower melting point than the welding metal, so that the envelope may be made quite thick without the extreme edges projecting excessively. As soon as the envelope has been made incandescent by the arc, the reaction sets in. The said reaction should not proceed so rapidly as to cause its main effect to take place on the welding rod itself, and the main portion of the reaction should not be completed until the envelope has already been melted. The envelope is then brought into extremely intimate contact with the work, heats it, and floating on the molten metal, heats the latter still further. The molten metal

has therefore time to be refined, and owing to the heat generated by the slag itself, it cools slowly, *i.e.*, the slag refines the weld. The welded metal then possesses a much higher ductility than can be obtained in the ordinary arc welding.—*December 31st*, 1931.

MISCELLANEOUS.

362,724. January 12th, 1931.—END COVERS OF PRESSURE VESSELS, W. Grötzinger, Karlsruher Strasse 19, Stuttgart-Cannstatt, Germany; and Baker, Perkins, Ltd., Hythe-road, Willesden, London, N.W. 10.

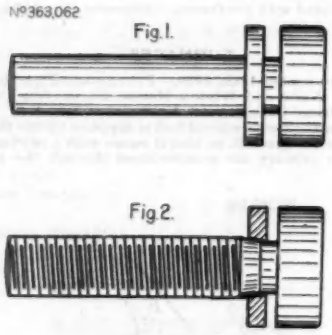
This invention is concerned with the construction of cylindrical vessels intended for high internal pressures. The end of



the vessel is counterbored as shown and the end disc is slipped in place with an elastic sealing ring A beneath. The locking ring B, which is made in four segments, as shown in the plan, is then put in place in the groove. The securing ring C is then inserted to ensure that the segments of the locking ring may not be displaced.—*December 10th*, 1931.

363,062. October 30th, 1930.—MAKING SCREWS AND WASHERS, E. Gundersen, Filestredet 25, Oslo, Norway, and H. Lahn, Riddervoldsgate 4, Oslo.

It is proposed to make screws with appended washers by form-



ing blanks, as shown in Fig. 1, and then screwing them as in Fig. 2. At the end of the screwing operation the die is used to shear off the washer from the stem by axial pressure.—*December 17th*, 1931.

Forthcoming Engagements.

Secretaries of Institutions, Societies, &c., desirous of having notices of meetings inserted in this column, are requested to note that, in order to make sure of its insertion, the necessary information should reach this office on, or before, the morning of the Tuesday of the week preceding the meetings. In all cases the TIME *and* PLACE *at which the meeting is to be held should be clearly stated.*

TO-DAY.

FARADAY HOUSE OLD STUDENTS' ASSOCIATION.—Hotel Russell, Russell-square, W.C. 1. Supper dance. 8 p.m. to 2 a.m. Tickets may be obtained from Hon. Secretary, Faraday House O.S.A., Southampton-row, W.C. 1.

INSTITUTE OF FUEL.—In the Lecture Theatre, Derby Technical College, Green-lane, Derby. "Industrial Furnace Design," by Mr. E. W. Plumley. 7 p.m.

INSTITUTION OF MECHANICAL ENGINEERS.—Storey's-gate, St. James's Park, S.W. 1. Informal Meeting. Discussion on "Pile-driving Plant," to be opened by Mr. C. H. Woodfield. 7 p.m.

JUNIOR INSTITUTION OF ENGINEERS.—39, Victoria-street, S.W. 1. Informal meeting. Lecture, "Notes on Hydraulic Installations in New Zealand," by Mr. H. S. Lamburd. 7.30 p.m.

OMNIBUS SOCIETY.—At the Institute of Marine Engineers, Minories, E.C. "City Traffic Problems," by Mr. H. Watson. 7 p.m.

PHYSICAL SOCIETY.—At the Imperial College of Science, Imperial Institute-road, South Kensington, S.W. 7. Meeting at 5 p.m. Editing Committee Meeting, 3.30 p.m. Council Meeting, 4 p.m.

ROYAL INSTITUTION OF GREAT BRITAIN.—21, Albemarle-street, Piccadilly, W. 1. Discourse, "Weather Forecasting," by Mr. G. C. Simpson. 9 p.m.

UNIVERSITY OF LONDON: UNIVERSITY COLLEGE ENGINEERING SOCIETY.—At University College, London, W.C. 1. Public Lecture, "High-pressure Locomotives," by Mr. H. N. Gresley. 5.30 p.m.

SATURDAY, FEBRUARY 6TH.

INSTITUTE OF BRITISH FOUNDRYMEN: LANCASHIRE BRANCH.—Grand Hotel, Manchester. Annual dinner. 6.30 p.m.

STAFFORDSHIRE IRON AND STEEL INSTITUTE.—Dudley Arms Hotel, Dudley. Annual Dinner. 6 for 6.30 p.m.

MONDAY, FEBRUARY 8TH.

CHARTERED SURVEYORS' INSTITUTION.—12, Great George-street, Westminster, S.W. 1. "Regional Planning and Economy," by Mr. Thomas Adams. 8 p.m.

INSTITUTE OF METALS: SCOTTISH LOCAL SECTION.—In the Rooms of the Institution of Engineers and Shipbuilders in Scotland, 39, Elmbank-crescent, Glasgow. "Aluminium-silicon Alloys: Their Properties and Some Applications," by Mr. R. B. Deeley. 7.30 p.m.

INSTITUTION OF ELECTRICAL ENGINEERS: NORTH-EASTERN CENTRE.—Armstrong College, Newcastle-upon-Tyne. "Electrically Driven Underground Conveyors in Coal Mines and their Economic Advantages," by Mr. W. B. Hird and Mr. J. B. Mavor. 7 p.m.

TUESDAY, FEBRUARY 9TH.

INSTITUTE OF MARINE ENGINEERS.—The Minories, London, E.C. 3. "A New Theory of Screw Propeller Action and its Application to the Unislip Propeller Design," by Mr. A. Kari. 6 p.m.

INSTITUTE OF METALS: NORTH-EAST COAST LOCAL SECTION.—Joint meeting with the Newcastle Branch, Institute of British Foundrymen, in the Electrical Engineering Lecture Theatre, Armstrong College, Newcastle-on-Tyne. "Some Developments in Non-ferrous Alloy Founding," by Mr. H. C. Dews. 7.30 p.m.

INSTITUTE OF METALS: SWANSEA LOCAL SECTION.—At the Y.M.C.A., Swansea. "Zinc—the Utility Metal," by Mr. E. Evans. 6.15 p.m.

INSTITUTION OF AUTOMOBILE ENGINEERS.—King's Head Hotel, Coventry. "Epicyclic Gearing," by Major W. G. Wilson. 7.30 p.m.

INSTITUTION OF CIVIL ENGINEERS.—Great George-street, London, S.W. 1. Discussion, "The Works for the Augmentation of the Supply of Water to the City of Cape Town, South Africa," by Mr. D. E. Lloyd-Davies; "The Construction, Testing and Strengthening of a Pressure Tunnel for the Water Supply of Sydney, N.S.W.," by Mr. G. Haskins. 6 p.m.

INSTITUTION OF ELECTRICAL ENGINEERS: SCOTTISH CENTRE.—Joint Meeting with the Institution of Engineers and Shipbuilders in Scotland, at the Engineers' Rooms, 39, Elmbank-crescent, Glasgow, C. 2. "Modern Methods of Electric Lamp Manufacture," by Mr. L. E. Buckell. 7.30 p.m.

INSTITUTION OF ENGINEERS AND SHIPBUILDERS IN SCOTLAND.—39, Elmbank-crescent, Glasgow, C. 2. Meeting cancelled.

INSTITUTION OF PETROLEUM TECHNOLOGISTS.—At the House of the Royal Society of Arts, John-street, Adelphi, W.C. 2. "Displacement Pumping as Applied to Oil Wells," by Mr. Albert Miller. 5.30 p.m.

MANCHESTER GEOLOGICAL AND MINING SOCIETY.—Queen's Chambers, 5, John Dalton-street, Manchester. "Corrosion by Underground Waters: A Dangerous Occurrence," by Mr. Neville Simpkin. 4 p.m. The Council will meet at 3 p.m.

SHEFFIELD METALLURGICAL ASSOCIATION.—198, West-street, Sheffield. "Metal Spraying," by Mr. Kenneth Gray. 7.30 p.m.

WEDNESDAY, FEBRUARY 10TH.

INSTITUTE OF FUEL.—Joint meeting with the Sheffield Chamber of Commerce, at the Cutlers' Hall, Sheffield. "The Utilisation of Coke Oven Gas in the Iron and Steel Industry," by Dr.-Ing. H. Lent, of the Vereingte Stahlwerke A.G. 6.15 p.m.

INSTITUTE OF METALS: LONDON LOCAL SECTION.—Joint meeting with the Electroplaters and Depositors' Technical Society, at the Northampton Polytechnic Institute, St. John's-street. "Some Recent Advances in Protective Coatings on Metals," by Mr. H. Sutton. 8.15 p.m.

INSTITUTION OF ELECTRICAL ENGINEERS: SOUTH MIDLAND STUDENTS' SECTION.—Joint Meeting with the Rugby Engineering Society. Alternative afternoon visits to G.P.O. Wireless Station, Hillmorton, or the British Thomson-Houston Company's Rugby Works. 3 p.m. White Heather Café, Rugby. "Recent Developments in Porcelain Insulators," by Mr. G. H. Halton. 7 p.m.

INSTITUTION OF ENGINEERING INSPECTION.—At the Royal Society of Arts, John-street, Adelphi, W.C. 2. "Reinforced Concrete Inspection," by Mr. O. Borer. 5.30 p.m.

ROYAL SOCIETY OF ARTS.—John-street, Adelphi, W.C. 2. "The Craft of the Decorative Iron Worker," by Mr. J. A. R. Stevenson. 8 p.m.

STEPHENSON LOCOMOTIVE SOCIETY.—Headquarters, King's Cross, N. 1. "Light Railways," by Mr. D. S. Barrie. 6.30 p.m.

TELEVISION SOCIETY.—At University College, Gower-street, London, W.C. 1. "Difficulties Encountered in Transmitting Pictures Over Telephone Circuits," by Mr. E. S. Ritter. 7 p.m.

THURSDAY, FEBRUARY 11TH.

INSTITUTION OF ELECTRICAL ENGINEERS.—Savoy-place, Victoria Embankment, W.C. 2. "Electrically Driven Underground Conveyors in Coal Mines and their Economic Advantages," by Mr. W. B. Hird and Mr. J. B. Mavor. 6 p.m.

INSTITUTION OF MUNICIPAL AND COUNTY ENGINEERS.—"The Carlton," Donegall-place, Belfast. Northern Irish District Meeting. 3.30 p.m.

INSTITUTION OF STRUCTURAL ENGINEERS.—10, Upper Belgrave-street, S.W. 1. "Heat Insulation in Cold Storage Construction," by Dr. Ezer Griffiths, F.R.S., and "Precooling Facilities for the Fruit Export Trade," by Mr. Edgar A. Griffiths. 6.30 p.m.

ROYAL AERONAUTICAL SOCIETY.—At the Royal Society of Arts, John-street, Adelphi, W.C. 2. "Mechanical Tests on Aircraft Structural Components," by Mr. I. J. Gerard. 6.30 p.m.

FRIDAY, FEBRUARY 12TH.

CHEMICAL ENGINEERING GROUP.—In the Rooms of the Chemical Society, Burlington House, Piccadilly, W. 1. "A New Method for Measuring the Mechanical Properties of Metals," by Mr. L. H. Hounsfield. 8 p.m.

INSTITUTION OF LOCOMOTIVE ENGINEERS: MANCHESTER CENTRE.—In the Building of the Manchester Literary and Philosophical Society, 36, George-street, Manchester, "Mechanical Breakdown," by Mr. L. W. Schuster. 7 p.m.

INSTITUTE OF METALS: SHEFFIELD LOCAL SECTION.—In the Non-ferrous Section of the Applied Science Department of the University, St. George's-square, Sheffield. "Spectrographic Methods of Chemical Analysis," by Dr. H. W. Brownsdon and Mr. E. H. S. van Someren. 7.30 p.m.

INSTITUTION OF ELECTRICAL ENGINEERS: LONDON STUDENTS' SECTION.—Savoy-place, Victoria Embankment, W.C. 2. "Mercury-arc Rectifier Phenomena," by Mr. H. H. Taylour. 6.15 p.m.

JUNIOR INSTITUTION OF ENGINEERS.—39, Victoria-street, S.W. 1. "Epicyclic Transmissions," by Major W. G. Wilson. 7.30 p.m.

KEIGHLEY ASSOCIATION OF ENGINEERS.—Queen's Hotel, Keighley. "Hydraulic Transmission Applied to Machine Tools," by Mr. C. L. Forbes. 7.30 p.m.

NORTH-EAST COAST INSTITUTION OF ENGINEERS AND SHIPBUILDERS.—In the Lecture Theatre of the Mining Institute, Newcastle-on-Tyne. "The Prevention and Insulation of Noise," by Dr. E. G. Richardson. 6 p.m.

NORTH-EAST COAST INSTITUTION OF ENGINEERS AND SHIPBUILDERS: GRADUATE SECTION.—Armstrong College, Newcastle-upon-Tyne. "The Trend of Modern Power Station Design, with Particular Reference to Prime Movers," by Mr. J. H. L. Tucker. 7 p.m. This is a Joint Meeting with the Students' Section of the Institution of Electrical Engineers.

RAILWAY CLUB.—Royal Scottish Corporation Hall, Fetter-lane, London, E.C. 4. Annual General Meeting, Presidential Address. 7.30 p.m.

ROYAL INSTITUTION OF GREAT BRITAIN.—21, Albemarle-street, Piccadilly, W. 1. Discourse, "Petroleum," by Sir John Cadman. 9 p.m.

MONDAY, FEBRUARY 15TH.

INSTITUTION OF SANITARY ENGINEERS.—Denison House, 296, Vauxhall Bridge-road, Victoria, S.W. 1. "Agreements for Personal Services," discussion to be opened by Mr. A. J. Martin. 7 p.m.

WOLVERHAMPTON AND DISTRICT ENGINEERING SOCIETY.—The Victoria Hotel, Wolverhampton. "Beet Sugar Manufacture," by Dipl. Ing. Karl Hampel. 7.30 p.m.

TUESDAY, FEBRUARY 16TH.

INSTITUTE OF INDUSTRIAL ADMINISTRATION.—In the Lecture Hall, Institute of Hygiene, 28, Portland-place, W. 1. "Elimination of Waste in Industry," by Mr. E. S. Byng. 6.30 p.m.

INSTITUTION OF AUTOMOBILE ENGINEERS.—Engineering Club, Queen-street, Wolverhampton. "The Possibilities of the Unorthodox," by Mr. Maurice Platt. 7.30 p.m.

INSTITUTION OF MECHANICAL ENGINEERS: NORTH MIDLAND STUDENTS' SECTION.—Hotel Metropole, Leeds. Address by Mr. R. G. Ward. 7.15 p.m.

WEDNESDAY, FEBRUARY 17TH.

INSTITUTE OF FUEL.—(This meeting has been postponed from February 10th.) Chemical Society's Rooms, Burlington House, Piccadilly, London, W. 1. "The Properties of Coals as Controlled by their Composition," by Professor George Hickling. 6 p.m.

INSTITUTION OF CIVIL ENGINEERS.—Great George-street, S.W. 1. Informal Meeting. Discussion, "The Cable as a Medium for Haulage," by Mr. W. Forster Brown. 6 p.m.

FRIDAY, FEBRUARY 19TH.

INSTITUTION OF CHEMICAL ENGINEERS.—Hotel Victoria, Northumberland-avenue, London, W.C. 2. Annual Corporate Meeting; Presentation of Medals, 11 a.m.; Presidential Address, "Control of Industry," by Mr. W. A. S. Calder, 12 noon; "Thermal Insulation," by Dr. Ezer Griffiths, F.R.S., 2.15 p.m.; Annual Dinner, 7 for 7.30 p.m.

INSTITUTE OF FUEL.—At the Engineers' Club, 17, Albert-square, Manchester. "The Maintenance of Uniformity in Industrial Fuels," by Dr. A. C. Dunningham. 7 p.m.

JUNIOR INSTITUTION OF ENGINEERS.—39, Victoria-street, S.W. 1. "The Ventilation and Cooling of Turbo-alternators," by Mr. D. MacFarlane. 7.30 p.m.

MANCHESTER ASSOCIATION OF ENGINEERS.—Midland Hotel, Manchester. Annual dinner. 6.45 p.m. for 7.15 p.m.

SATURDAY, FEBRUARY 20TH.

INSTITUTION OF MUNICIPAL AND COUNTY ENGINEERS: SOUTH-EASTERN DISTRICT MEETING.—Assemble at Vestry Hall, London-road, Mitcham. 11.30 a.m.

MONDAY TO SATURDAY, FEBRUARY 22ND TO MARCH 5TH.

BRITISH INDUSTRIES FAIR, 1932.—Castle Bromwich, Birmingham, to March 4th, 1932; Olympia, London, to March 3rd, 1932; White City, to March 5th, 1932.

WEDNESDAY, FEBRUARY 24TH.

INSTITUTION OF AUTOMOBILE ENGINEERS.—Engineers Club, Albert-square, Manchester. "The Possibilities of the Unorthodox," by Mr. Maurice Platt. 7 p.m.

INSTITUTION OF ELECTRICAL ENGINEERS: LONDON STUDENTS' SECTION.—Visit to Venner Time Switches, Ltd., Raynes Park, 3 p.m. Annual Dinner at the Florence Restaurant, Rupert-street, W. 1. 7.15 for 7.30 p.m.

SOCIETY OF GLASS TECHNOLOGY.—Joint Meeting with the Ceramic Society, Sheffield. Visit to Department of Refractory Materials, St. George's-square. 9.15 to 10.45 a.m. In the Applied Science Department, The University, St. George's-square, Sheffield. "The Strength of Materials as Affected by Discontinuities and Surface Conditions," by Professor F. C. Lea; "The Tensile Strength of Glass," by Mr. E. J. Gooding; 11 a.m. "The Crystal Structure of Sillimanite and Related Materials," by Dr. W. H. Taylor; "Studies of Clay Mixtures for Glass Melting Pots: Part IV., The Corrosion-resisting Properties," by Dr. J. H. Partridge, Mr. G. F. Adams and Mr. J. R. Lait; 2.30 p.m.

THURSDAY, FEBRUARY 25TH.

INSTITUTION OF MUNICIPAL AND COUNTY ENGINEERS: SOUTHERN DISTRICT MEETING.—Assemble at Guildhall, Abingdon, at 11 a.m.

FRIDAY, FEBRUARY 26TH.

INSTITUTION OF LOCOMOTIVE ENGINEERS.—Trocadero Restaurant, Shaftesbury-avenue, London, W. 1. Annual Dinner. 6.30 for 7 p.m.

JUNIOR INSTITUTION OF ENGINEERS.—39, Victoria-street, S.W. 1. "Recent Applications of the Ternary Alloys of Lead," by Mr. Kenneth Gray. 7.30 p.m.

MONDAY, FEBRUARY 29TH.

INSTITUTE OF METALS.—Official visit to British Industries Fair, Castle Bromwich, Birmingham.

ENGINEERS' GERMAN CIRCLE (DEUTSCHER INGENIEURZIRKEL).—At the Institution of Mechanical Engineers, Storey's-gate, Westminster, S.W. 1. "Leistungen der deutschen Technik 1931" ("German Technical Accomplishments in 1931"). Illustrated with lantern slides, by Herr Oberingenieur Carl Derschow. 6 p.m.

TUESDAY, MARCH 1ST.

CHEMICAL ENGINEERING GROUP.—Caxton Hall, Westminster, S.W. 1. "Some Problems Connected with High-speed Compression-ignition Engine Developments," by Mr. C. B. Dicksee. Joint General Meeting with ten other societies. 7.45 p.m.

WEDNESDAY, MARCH 2ND.

INSTITUTION OF AUTOMOBILE ENGINEERS.—Queen's Hotel Birmingham. "The Possibilities of the Unorthodox," by Mr. Maurice Platt. 7.30 p.m.

MONDAY, MARCH 7TH.

WOLVERHAMPTON AND DISTRICT ENGINEERING SOCIETY.—The Victoria Hotel, Wolverhampton. "Steam Generation in Factories," by Mr. H. E. Partridge. 7.30 p.m.

By arrangement with Reuter's Engineering Service, THE ENGINEER contains the latest news from all parts of the world which is likely to be of interest to engineers.